ON THE COVER

IN ASSEMBLING panels to be used in making furniture, narrow strips of wood are glued together along the edges. Until recent years, these assemblies were held in mechanical clamps until the glue had set—a matter of several hours. Now they are "tacked" together at various points along the glue lines in a few seconds by radio-frequency current, which generates heat that greatly accelerates the setting of the glue. These local bonds hold the pieces tight against one another until the remainder of the glue can set in its normal time of three to four hours.

Our cover picture shows an electronic press or "clamp" that is used in this new procedure. It is in the plant of the Brown-Saltman Furniture Company at South Gate, Calif., and was designed by George Linquist, a glue consultant of Santa Barbara, Calif. On the left side of the press are four air cylinders that exert side pressure on the glued assembly as it passes through the machine on rollers. Two other air cylinders, stationed overhead, push downward to prevent the side thrust from buckling the panel.

Current is furnished by a Westinghouse radio-frequency generator having an output rating of 5 kw. It is applied through a system of staggered electrodes by means of which the heat is delivered to setting points that are distributed along the glue lines in a zigzag pattern. The press will accommodate panels up to 42x72 inches in area and will "spot glue" as much as 125 linear feet of glue line in as little as five seconds. The machine is being used to make components for radio cabinets, tables, chests, etc., from poplar, ash, and mahogany stock.

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IN THIS ISSUE

THE building of large dams is gradually approaching an exact science. At Bull Shoals Dam, now beginning to take form on the White River in Arkansas, both the planning by the Army Corps of Engineers and the construction techniques being used by Ozark Dam Constructors reflect the cumulative knowledge and experience gained from the rearing of similar structures elsewhere. Our leading article tells how the work is being done.

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ANCIENT peoples devised the ingenious "lost-wax" process of casting metals to create art objects. Modern industry has adopted it to produce parts of machines and appliances with such exactness that they require no subsequent machining. See Page 135.

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KEEPING pace with the growing demand for electricity in the area it serves, the Interstate Power Company has recently placed in service at Clinton, Iowa, a new steam-driven generating station that illustrates the trend of modern design and equipment in this field. Page 139.

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ADVERTISING INDEX

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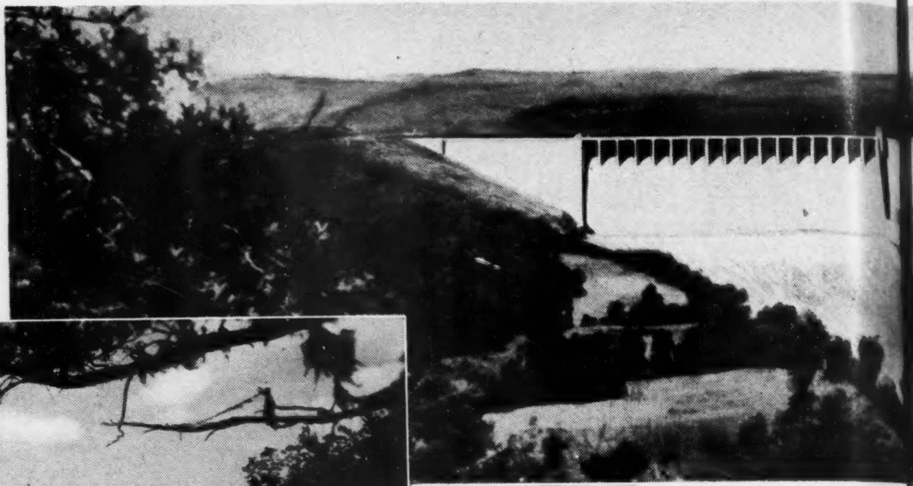
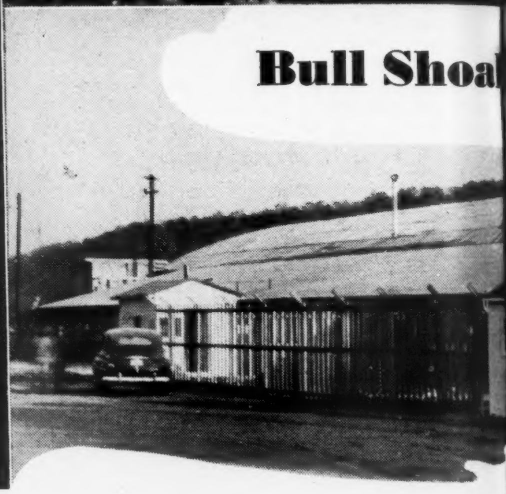
DAM SITE AND MODEL

Below is an upstream view of the White River at Bull Shoals taken last August when work on the dam was being started. A section of the 16-mile access railroad built from Cotter, Ark., is seen in the foreground. How the structure will look when completed is indicated at the right. It is a picture of a model of Bull Shoals Dam superimposed on a photograph of the site.

PHOTOS, CORPS OF ENGINEERS



Bull Shoa am



IN A SCENIC upland section of northwestern Arkansas, construction crews are rounding out their first year of work on Bull Shoals Dam, laid out and directed by the Corps of Engineers, U. S. Army. By September they will be placing concrete for a 283-foot-high barrier across the White River that will be the most massive structure of its kind east of the Rocky Mountains and fifth largest in the country. Its purposes are flood control and power generation. An incidental benefit will be the creation of a recreation area of special appeal to fishermen and boating enthusiasts.

The estimated cost of the project, completed, is $69,400,000, but the actual expenditure will be determined by the trend of prices for labor and materials during the building period. Current operations include the necessary excavation work and erection of the dam, together with the accessory undertaking of quarrying, transporting, and processing the concrete aggregates that will be required. A group of nine contractors is carrying on these activities. Under the name of Ozark Dam Constructors, it is executing a $22,146,000 contract covering excavation and dam construction, with the Government furnishing the cement. As Flippin Materials Company, it was awarded the $9,301,000 aggregate-production contract. The dam is scheduled for completion by December 1, 1950. Contracts for building and equipping the powerhouse, clearing the reservoir site, and other essential work, will be let as Congress appropriates additional funds.

WHEN completed in 1950, Bull Shoals Dam will replace Friant Dam in California as the nation's fifth-largest water-storage structure.

At least two innovations in construction methods are being introduced at Bull Shoals: First, the employment of a gravity-type concrete cofferdam instead of a conventional one with cellular, steel-pile walls; and, second, the precooling of concrete aggregates and sand as an aid in controlling the heat that will be generated as the concrete sets. The contractor has devised ingenious and novel procedures for the latter purpose.

Other outstanding features of the work will be the quarrying of four million tons of stone for concrete aggregates and sand and its transportation to the dam site on a 7-mile overland belt system that will be the second longest ever built.

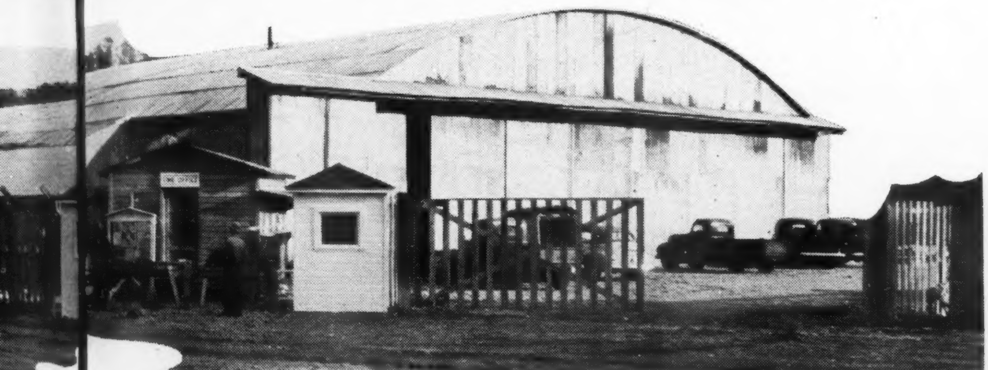
Private power interests have long eyed this general stretch of the White River as a desirable location for generating electricity. In 1910, Congress approved an application of the Dixie Power Company to dam the stream at Wild Cat Shoals, about 10 miles below the present dam site, but President Taft vetoed it. The same concern obtained a construction permit in 1919, but could not arrange to finance the venture. Subsequently, the White River Power Company took over the project but abandoned it when the Federal Power Commission rescinded the license in 1938. Building of a dam at Wild Cat Shoals was recommended to Congress in 1931 in an Army Engineers report that included data on seven additional proposed structures.

In 1937 the Chief of Army Engineers submitted a comprehensive flood-control plan for the Ohio and Lower Mississippi rivers that advocated six dams in the White River Basin. Initiation and partial execution of this program was made possible in 1938 when Congress appropriated $25,000,000 to put it underway. Two years later, the Bull Shoals site was recommended because it offered better foundation rock than the Wild Cat Shoals location and construction was

Dam *C. H. Vivian*

CONTRACTOR'S BUILDINGS

The office and main shops of Ozark Dam Constructors at the dam site. The payroll now numbers 400 and will rise to 1200 or more at the height of concrete-placing operations.



ROADBUILDING

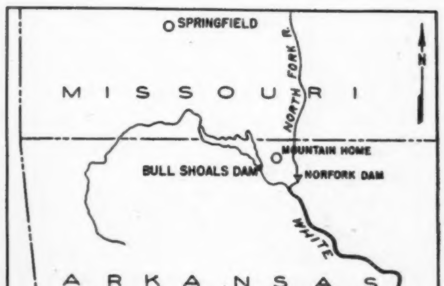
An angle dozer working on a steep side-hill slope during the construction of a 10-mile access road to the dam site in 1946.

declared to be economically justified. Acting on this information, Congress modified the White River Basin Plan in 1941 to include Bull Shoals.

Before starting work on damming the White River, the Army Engineers elected to build Norfork Dam on its North Fork, which enters the parent stream a few miles below Bull Shoals. This is a 230-foot-high concrete structure with a powerhouse at its downstream base. One 35,000-kw. generator is installed there, and a similar unit is soon to be put in. The Flood Control Act passed by Congress on December 22, 1944, directed that surplus energy from projects of the Corps of Engineers in that area be sold in wholesale blocks in a manner to encourage its widespread use. To accomplish this, the Southwestern Power Administration was set up under the Department of the Interior to transmit and market the available power. Thus far, it is handling only the output of Norfork Dam and Denison Dam, which is on the Red River in Texas and likewise has a capacity of 35,000 kw. that is shortly to be doubled. The Southwestern Power Administration is now connecting the Norfork and Denison plants with a high-voltage line, and when the Bull Shoals station goes into service, with an initial capacity of 120,000 kw., it also will be tied in.

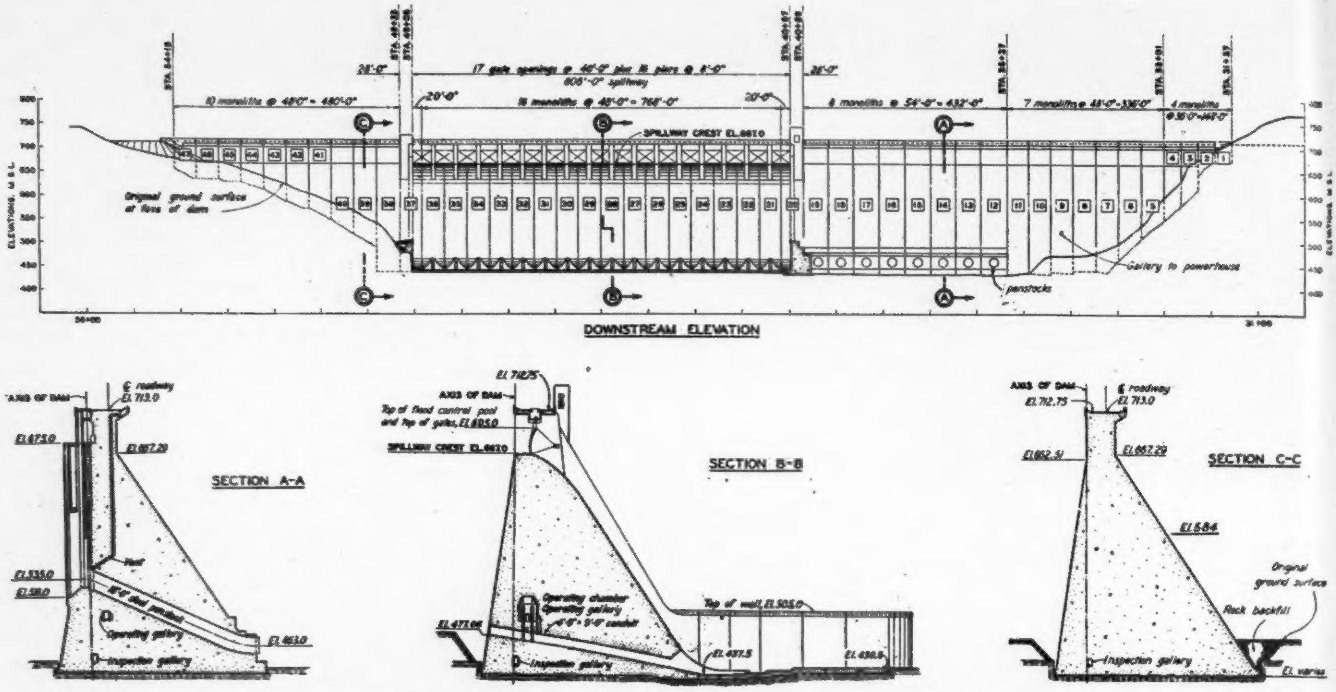
The outbreak of World War II delayed construction of Bull Shoals Dam, although the project was given emergency status while the conflict was in progress because a shortage of power had developed in eastern Arkansas. This was met by running a line from Pickwick (Tenn.) Dam of the Tennessee Valley Authority, but later, when it became apparent that all available TVA power could be used to advantage in its own territory, a movement to expedite work on Bull Shoals was initiated. Actually, bids were not received until July, 1946, at which time a combination of seven contracting firms under the name of White River Constructors submitted the low figure of $24,264,000. The award was held up for six months, and then the successful bidder refused to sign a contract because costs had risen during the intervening period. New bids were opened in May, 1947, under amended specifications that excluded furnishing concrete aggregates and cement. The same group, which had meanwhile added two more firms and changed its name to Ozark Dam Constructors, submitted the low bid and was given authority to proceed.

The White River rises in the Ozark Mountains in northwestern Arkansas, loops northward into southern Missouri, and then flows southeastward through Arkansas to enter the Mississippi a few miles north of Arkansas City. In some



LOCATION MAP

Bull Shoals Dam is being reared in Marion County, Arkansas, about 170 miles north of Little Rock. It will back up the waters of the White River to Ozark Beach Power Dam near Forsyth, Mo., and create a reservoir with a shore line of 740 miles. Norfork Dam, completed a few years ago on a tributary of the White River, is 25 miles from Bull Shoals.



DOWNSTREAM ELEVATION AND SECTIONS

As indicated in the top drawing, the dam will be made up of 47 monoliths of concrete. The 808-foot spillway will have a maximum discharge capacity of 230 million gallons per minute. Section A-A shows the course of one of the eight 18-foot steel penstocks that will deliver water to the generating units in the powerhouse at the downstream toe. The power plant is not included in the present contract. Section B-B shows one of the sixteen 4x9-foot flood-control conduits to be located in the basal part of the spillway section of the dam. When concrete has been placed the length of the structure to Elevation 584, indicated in gravity section C-C, filling of the reservoir will begin.

years it has done considerable flood damage mainly to farmlands and in small cities. The high-water period normally comes between January and June, but floods have occurred in every month.

The drainage basin above Bull Shoals dam site is 6036 square miles in extent. From a mean annual rainfall of 44 inches, the runoff ranges between 5.8 and 34.1 inches and normally is 14 inches. Bull Shoals Reservoir, with a full-pool surface area of 71,200 acres, will be capable of impounding 5,408,000 acre-feet of water, which is equivalent to a runoff of 16.8 inches from the entire upstream watershed. The 2,360,000 acre-feet of storage between Elevations 654 and 695 will be reserved for flood control. The prospects are that water will be stored in this zone an average of 20 days annually, although for much longer periods in some years and not at all in others. That part of the pool below Elevation 654 will, then, normally be used for power generation.

The dam will be a straight gravity-type structure 2256 feet long at the crest and containing 2,100,000 cubic yards of concrete. From a maximum basal thickness of 230 feet it will taper to a width of 34 feet. Nonoverflow sections of 940 and 508 feet at the left and right ends, respectively, will flank a central 808-foot-long overflow section having seventeen taintor gates, each 40 feet long and 28 feet high, for regulating the discharge. Sixteen flood-control conduits, with their inverts 27 feet above the streambed level, will pass through the base of the spillway section. They will normally be closed by gates that can be operated from a gallery running longitudinally through the dam. The powerhouse at the base of the left nonoverflow section will initially contain three 67,500-hp. turbines driving 40,000-kw. generators and will have space for an additional unit, which will be added when it is needed. Eventually the station will be extended to provide room for a total of eight 40,000-kw. generators.

Prior to calling for bids on dam construction, the Government carried out considerable preliminary work to make the site easily accessible. A 16-mile stretch of standard-gauge railway was built along the river from Cotter, Ark., on the Missouri Pacific system, and a 10-mile access road was constructed from Arkansas Highway No. 5. Both were contracted undertakings.

Ozark Dam Constructors began operations soon after being authorized to proceed on June 10 of last year. The first major task was to divert the stream through a 300-foot-wide channel cut through a flood plain along the steeply sloping left bank and to enclose the remainder of the site within a cofferdam to permit excavating in the dry. It was originally intended to provide a conventional-type cellular-walled cofferdam of interlocking steel piling, but as steel was virtually unobtainable and time was pressing, it was decided to depart from established practice by building the cofferdam for the most part of concrete. Conditions favoring this procedure were a shallow overburden and an evenly sloping hard-rock bottom, an abundance of acceptable aggregate materials, and native lumber for forms.

Accordingly, river-run gravel was used without screening it, and a total of 1580 linear feet of 45-foot-high wall was placed to form the upstream and river arms of the structure. The downstream section is an 850-foot earth-and-rock-fill embankment. The cofferdam confines an area of more than eighteen acres, within which is included approximately 65 percent of the length of the dam at foundation level. Some grouting was done underneath the latter and proved tight enough to exclude the river, for no water was encountered until the excavation was well below stream elevation. The cofferdam was constructed so that it could be flooded if necessary by admitting water through four 36-inch Hardesty gates, and also sufficiently strong to withstand overtopping by the stream should a flood of 150,000-second-feet magnitude be experienced.

After that part of the dam within the cofferdam has been constructed to a height above the flood-control conduits, the river will be diverted through these openings and another cofferdam built to enclose the section through which the stream is now passing. To facilitate shifting the river's course, a concrete slab was poured on the bed and at the upstream end of the present channel to

form a footing for a line of buttress piers of concrete extending from the river end of the upstream cofferdam arm to the left bluff. There are sixteen of these piers, spaced on 23-foot centers, and each is 3 feet thick, 80 feet long at the bottom, and 12 feet at the top. The upstream faces are on a 1 to 1.2 slope.

When the river flow is to be changed, precast concrete stop logs, from 18 to 30 inches thick and 23 feet long, will be dropped into position on the upstream side of the piers to effect the closure. Because the upstream wall of the first-stage cofferdam rises to a point about 15 feet above the bottoms of the conduit openings through which the second-stage diversion will be made, it will be necessary to blast off that much of the top of the concrete wall. With this in mind when it was being placed, 3-inch-diameter paper tubes were set vertically at suitable intervals to receive the blasting charges and were plugged to keep out dirt and water until they are needed.

Excavating for the foundation is well along in the first-stage cofferdam and most of the trimming and cutting of the abutment recesses for the flanks of the dam is done. Indications are that not more than around 35 feet of bottom, and considerably less in most areas, will have to be removed to establish sound footings. The rock is a dolomitic limestone that lies in an almost horizontal plane. It contains irregular beds of chert of unpredictable distribution and thickness. These extremely hard sections have tried the mettle of drilling equipment and crews, but progress has been generally satisfactory. All primary drilling is done with Ingersoll-Rand X-71 drifters on Type D wagon mountings. There are fourteen of these machines, of which from six to eight are normally stationed in the cofferdam. Fifteen Jackhamers, mostly J-50's, do secondary drilling, and ten paving breakers are utilized for trimming and miscellaneous work. The total estimated excavation for the job is 850,000 cubic yards—450,000 rock, and 400,000 common.

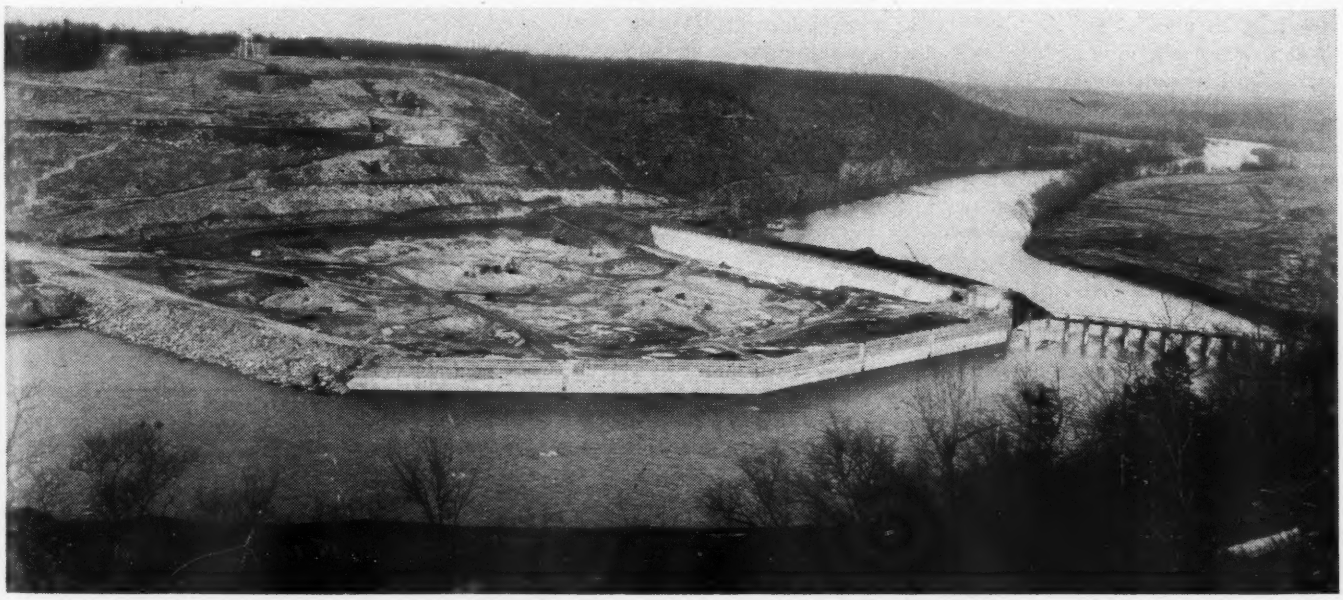
Stud-type Jackbits are used for all wagon drilling. Holes are ordinarily started with bits of $2\frac{5}{8}$-inch gauge, with a subsequent reduction of $\frac{1}{16}$ inch at each steel change. Hole spacing varies with the rock but serves to break it into convenient sizes for handling, firing being done electrically with Hercules explosives. One Northwest and two Lima power shovels load the blasted material into ten Euclid 12-yard trucks. Thus far most of it has been disposed of nearby to fill in low spots in and about the general yard area, and the remainder is dumped along the river banks downstream.

Up to 500 Jackbits and a variable quantity of drill rods are reconditioned daily in a shop that contains Ingersoll-Rand equipment, including a sharpener, pyrometer-controlled furnaces, a Jackmill, a quenching fixture, a cutoff wheel, and other appliances. A crew of four men working one shift takes care of the bits and steel for three shifts of drillers in the dam area as well as those used at the quarry. On an average, each Jackbit is used five times before being discarded.

During the early stages of drilling, compressed air was supplied by three 500-cfm. and two smaller portable units. Meanwhile, a compressor house was being constructed atop the right bluff and equipped with three 2-stage, electrically driven machines that deliver 6900 cfm. for drilling and general purposes. In addition, an Ingersoll-Rand Motorcompressor with a capacity of 600-cfm. has been installed as an independent source of air to be used for operating the pneumatic equipment of the mixing plant when placing of concrete starts. Besides, three ammonia compressors are now being assembled to provide the refrigeration that will be needed to precool the aggregates, chill water for mixing, and cool the concrete.

Preliminary investigations at the dam site by the geological staff of the Corps of Engineers revealed that the foundation rock was generally sound and would require little consolidation by grouting—findings that are being corroborated by the exploratory work and actual excavating being done by the contractor. As an indication of the care with which sites for such structures are nowadays selected, it is interesting to note that the government geologists drilled nearly 100,000 feet of diamond-drill holes to make certain that Bull Shoals was the most satisfactory of the several possible locations in that general stretch of the river.

To determine foundation grade, the contractor is drilling from four to six 3-inch diamond-drill holes in a variable pattern under the location of each block



FIRST COFFERDAM

Approximately two-thirds of the length of the base of the dam will be built within this 18-acre enclosure which has upstream and riverward walls of concrete 45 feet high. After that part of the structure has reached an elevation above the level of the flood-control conduits, the river will be diverted through the latter and a second cofferdam will be constructed to enclose the remaining third of the foundation. The stream flow will be shifted by placing concrete stop logs back of the line of concrete piers shown crossing the river at the right. Atop the bluff on the left is a water-supply tank and back of it the compressor building. Air-distribution pipes extend down the hill from the latter and are carried around the working area on top of the cofferdam.

BLAST-HOLE DRILLING

Blast holes for excavating in the foundation and abutment areas are put down with Ingersoll-Rand X-71 drifter drills on wagon mountings. At the left is a view of two of these rigs attacking the right abutment during the early stages of the work. The other picture shows six drills of the same type operating in the foundation area.

of concrete. These holes are drilled to varying depths, with 80 feet the maximum. The formation is then tested for tightness with water under pressure, and if that indicates need for grouting, it is done. The blocks will be 48 feet wide except in the penstock section, where they will be 54 feet.

The contractor is also required to drill up to 1200 linear feet of hole 36 or 40 inches in diameter to extract large cores for close examination and to provide access for geologists so they can inspect the rock in place. An Ingersoll-Rand WF-3 Calyx drill is being used for this purpose. A curtain of grout to arrest the passage of water underneath the dam will be placed by the Corps of Engineers' staff after the structure has been partially completed. A line of diamond-drill holes, 6 feet apart and inclining upstream at an angle of 15°, will be drilled for the purpose from within the gallery running through the interior. Drainage holes inclined 15° downstream will be put down on 8- and 9-foot centers on another line.

Laboratory tests proved that aggregates obtainable at the site would not produce concrete of satisfactory durability because of the presence of chert, stylolitic partings, and other deleterious materials and features. Subsequently, government technicians spent some nine months in locating a source of suitable material. They found it at the top of Lee Mountain, about 7 airline miles from the dam. There the contracting firm, under its alternate name of Flippin Materials Company, is opening a quarry to furnish rock that will be crushed to aggregates of the required sizes and further reduced to provide sand. The rock is a limestone, but is of younger geologic age than that at the construction site and is comparatively free from chert and other undesirable minerals.

In order to take out the two million cubic yards (four million tons) of stone that will be needed, approximately 750,000 cubic yards of overburden and unwanted rock will have to be removed. The quarry will eventually be around 4000 feet long and will extend from 300 and 400 feet into the mountainside. It is planned to work an 80-foot face and to break down the material by means of large-diameter, vertical blast holes. A peak production of 5000 cubic yards in two shifts per day is scheduled. A 2-stage crushing and screening plant housing 42- and 30-inch gyratory crushers will reduce the stone to a maximum size of 6 inches before it leaves the quarry.

To transport the material to the dam site, the contractor is building across hilly, wooded country a 7-mile belt-conveyor system that will rank next in length to the record-holding system that was utilized at Shasta Dam in California. Consisting of 30-inch-wide belting in 21 flights powered by eighteen 100-hp. and three 75-hp. motors, the conveyor will have a carrying capacity of 650 tons per hour at a speed of 550 feet per minute. Lengths of individual flights will range from 1100 to 4200 feet, depending upon the terrain. To facilitate construction and subsequent servicing, a 20-foot roadway will parallel the belt system, and the 100-foot right of way that has been cleared will also have power and telephone lines.

In the aggregate preparation plant, to be located on top of the right bluff of the river overlooking the dam site, the quarried stone will be converted into four sizes of aggregates and three of sand. The belt line from the quarry will discharge the material in a live storage area of 10,000 tons capacity. From this pile it will be fed through air-operated gates onto a 36-inch conveyor running in a tunnel underneath it and having a

CALYX CORE DRILL

The contractor is required to drill up to 1200 linear feet of 36- or 40-inch-diameter hole to provide cores of foundation rock for examination and to enable geologists to descend into the openings to inspect the formation in place. This work is being done with the Ingersoll-Rand Calyx core drill shown. It is powered by a 35-hp. gasoline engine.

OPENING THE QUARRY

Four million tons of limestone will be quarried and transported 7 miles to the dam site to provide aggregates and sand for making concrete. The view at the left shows the scar on top of Lee Mountain that will eventually be developed into a working face 4000 feet long and 80 feet high. The two other pictures show a 500-cfm. portable Mobilair compressor and one of several wagon drills that are being used in preliminary stripping operations to expose sound rock.

carrying capacity of 800 tons an hour.

In the first of two screening plants the stone will pass over a double-deck vibrating screen to separate it into three sizes. The two larger sizes—3 to 6 inches and 1½ to 3 inches—will be transported to individual stockpiles on 24- and 30-inch belts. Material falling through the lower-deck screen will be crushed by a 66-inch Symons cone and carried to No. 2 screening plant on a 30-inch conveyor at the rate of 400-600 tons an hour. There, by means of two more vibrating screens, it will be separated into three sizes. Some of the time, the two larger sizes—¾ to 1½ inches and No. 4 mesh to ¾ inch—will be delivered to aggregate stockpiles, while material smaller than No. 4 mesh will go to the sand-plant stockpile. But when there is need for more sand, the entire output of No. 2 will be carried to the sand-plant stockpile. It will also be possible at No. 1 screening plant to divert the material for sand-making purposes after it has been crushed instead of building up a surplus of the two largest sizes of aggregates.

All sand will be made by the dry method, and from the time the raw material is stockpiled until the final product is used will be kept under cover to protect it from the weather. The processing plant will have three hammer mills, two impactors, and three air separators. The latter machines work on the centrifuge principle and create their own air currents. The larger, heavier particles drop through a central opening, while the smaller, lighter ones are thrown outward by centrifugal force. The sand will thus be graded into three sizes: No. 4 to 30 mesh, 30 to 100 mesh, and 100 to 200 mesh. As in the case of the aggregates, they will be stockpiled separately. Some sand will be stored for use in sandblasting the finished dam. It is believed that the process will produce an excess of fine components, some of which will be wasted.

Heat generated in the mass concrete by chemical action during setting will be prevented from reaching harmful proportions by steps that represent an advance in the technique introduced at Hoover Dam and afterward extended and improved upon at Grand Coulee and at other large dams in the West. The specifications stipulate that the concrete shall be placed at a temperature of not more than 65°F. and as low as 50° during the hotter seasons of the year, and that further cooling during and after placing shall be accomplished by circulating refrigerated water in pipes embedded in the concrete. The contractor may cool the concrete and circulating water by any suitable means, and Ozark Dam Constructors has shown initiative in devising some of the methods it will employ.

Recent practice elsewhere has been to precool concrete solely by the use of chilled or iced mixing water. But as this procedure at Bull Shoals would entail the addition of so much water as to increase its proportion beyond the limits specified for the mix, it will be supplemented by precooling the aggregates and the sand. The aggregates will be chilled by immersing them for whatever

length of time may be required in water at 35°F. circulated at the rate of 2000 gpm. in large steel tanks, using four at a time and alternately charging one set and then the other. The contractor calls this the inundation process. Because of the restriction against wetting sand before it enters the concrete mixers, it will be cooled in apparatus based on the heat-exchanger principle. The sand will descend by gravity through vertical tubes mounted in two cylindrical tanks and surrounded by 35° water flowing upward.

Both the aggregate and sand coolers will be housed in a refrigerated building to which the materials will be delivered from their respective stockpiles by belt conveyors. The feed to the belts will be controlled in order to blend the various sizes, and they will be further mixed in passing through the coolers. From the cooling to the concrete mixing plant the aggregates and sand will travel on a 36-inch belt having a capacity of 800 tons per hour. This conveyor system will be insulated and enclosed, and cold air circulated through it will be discharged with the materials into their respective storage bins and help to keep them cool until they are used. The water for mixing the concrete will have a temperature of 35°.

In addition to the precooling provisions, from 12 to 28° of heat will be extracted from the concrete after it is in place. This will be accomplished by circulating 50° water through grids of 1-inch piping spaced 5 feet apart horizontally and embedded in the blocks at the 5-foot intervals that constitute separate pours. Cooling will be done both during and after placing, thereby differing from the procedure followed at Hoover and Grand Coulee dams, where only after-pouring cooling was practiced. When the river water drops to a temperature of 50° it will be used for cooling and then wasted. At all other times refrigerated water will be circulated in a closed system and recooled during each cycle. To take care of the various cooling needs, a refrigeration plant of 1640 tons capacity will be provided, and it is estimated that 1400 tons of this will be required.

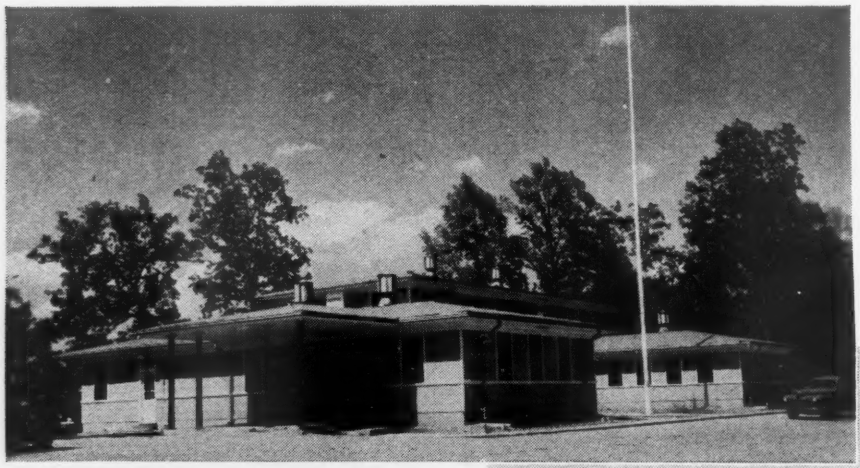
The concrete mixing plant, containing four 4-cubic-yard Koehring mixers and Johnson automatic weigh batchers, is the one that was used at Conchas Dam in New Mexico, Friant Dam in California, and Dale Hollow Dam, Tennessee, and is half the size of the Grand Coulee plant. The concrete will be hauled in 4-cubic-yard Blaw-Knox vertical-side, air-dumped buckets, four to a train, onto a steel trestle located 125 feet downstream from the dam axis and will be moved from the cars by cantilever and revolving cranes. It will be dumped into Blaw-Knox steel cantilever forms and vibrated. The mix will be lean in cement, with three sacks to the cubic yard. It will contain an air-entraining agent to give it better flow characteristics and to impart to it resistance to freezing. Both portland and natural cement will be used, and the quantity required is estimated at 1,800,000 barrels. It will arrive in bulk and be transferred from railroad cars to silos by pneumatic conveyor.

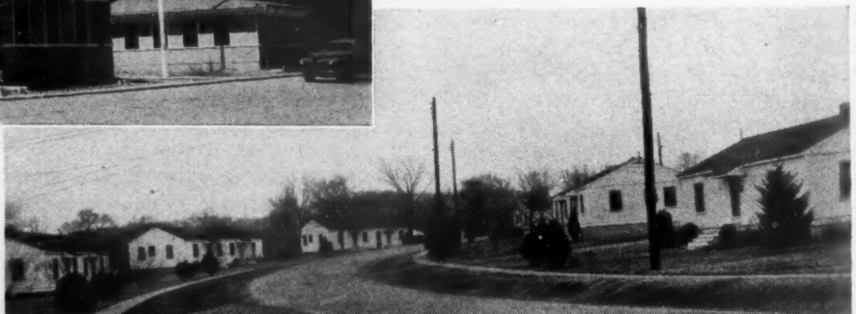
From the time concrete placing starts, approximately 24 months will be required to complete the dam. Of the 47 blocks in the structure, 29 will be in the first cofferdam area. However, until placing can be carried on the full length of the structure progress will necessarily be somewhat restricted, especially because it will not be permissible to have a height difference greater than 15 feet between blocks. It is expected that there will be about three months during which the work can be carried on from end to end of the dam, and then the contractor hopes to place around 200,000 cubic yards of concrete per month.

Col. G. E. Galloway, U. S. District Engineer, heads the Little Rock, Ark., office of the Corps of Engineers that is directing the building of Bull Shoals Dam. W. W. Ralphe is chief of the construction division. Ralph P. Johnson is resident engineer at the dam, with Lincoln Sherman as his assistant.

Member firms of Ozark Dam Constructors are: Brown & Root, Inc., Houston, Tex.; Wunderlich Contracting Company, Jefferson City, Mo.; Morrison-Knudsen Company, Inc., Boise, Idaho; Peter Kiewit Sons Company, Omaha, Neb.; J. C. Maguire & Company, Los Angeles, Calif.; Winston Bros. Company, Minneapolis, Minn.; David G. Gordon, Denver, Colo.; Condon-Cunningham Company, Omaha, Neb.; and Chas. H. Tompkins Company, Washington, D. C.

Brown & Root, Inc., is the sponsoring firm for the coventurers and is represented by Ross White as project manager. Key operating personnel for the contractors are: H. H. Roberts, chief engineer; J. Grady Gray, office manager; and the following departmental superintendents, Guy Smith, electrical; Dave Williams, mechanical; C. H. Norris, excavation; E. Earnest, drilling and grouting; Harry Vine, quarry; Ted Davis, conveyor system; Ben Clark, rigging; and J. Milam, carpentry.





GOVERNMENT BUILDINGS

As Mountain Home, Ark., was within easy traveling distance of the sites of three proposed dams, the Corps of Engineers established homes there for personnel prior to building Norfork Dam. The same facilities, with additions, are now being occupied by the engineering staff engaged in the construction of Bull Shoals Dam. An office building, with guest rooms on the second floor (above), was erected on top of the right bluff of the river overlooking the dam site. It is to be a permanent structure.

Casting Metals in Ceramic Molds

An Ancient Art is Now a Tool of Industry

W. P. Gillingham

COURTESY, BROOKLYN MUSEUM

ANCIENT AND MODERN PRODUCTS

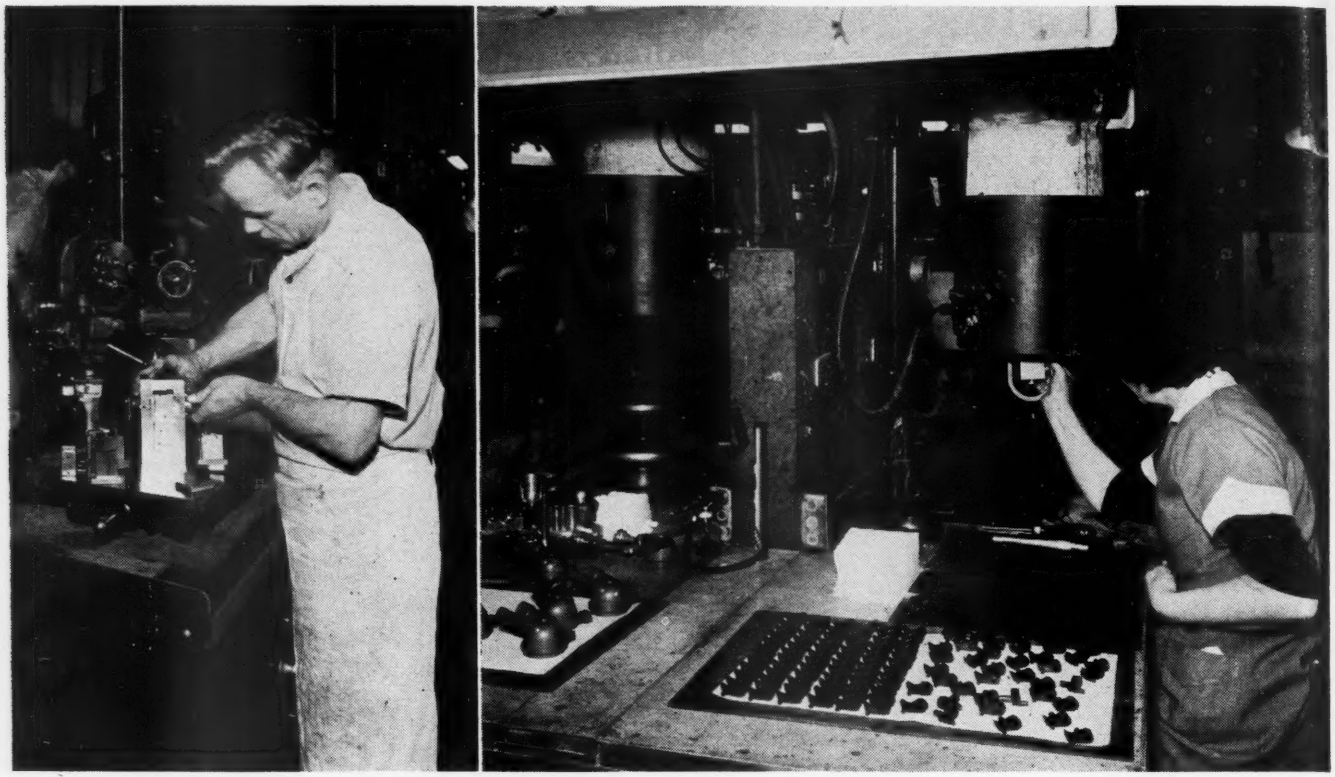
Centuries ago, art objects were produced in many lands by the "lost-wax" process. An example, pictured at the lower-right, is an 8-inch-high solid-gold flask made by Indians of Colombia, South America, in the pre-Spanish era. Precision casting of mechanical parts was started during World War II, and its advantages for certain types of work have secured it a place in the industrial world. It is especially suitable for the manufacture of small parts of intricate shape. Pictured at the left are mated members of a clutch assembly turned out by Arwood Precision Casting Corporation. The combined length of the two pieces is about 1½ inches. The center view shows various Arwood products on the final-inspection table.

MUCH of our knowledge of ancient peoples has come from the works of art which they left behind as tangible evidence of their existence. Relics such as ornamental vases, jewelry, and graceful statuary have given us glimpses into the lives of the men who fashioned them. Many of those objects were cast in gold, silver, bronze, or other metals by what is known as the "lost-wax" process that has been adapted to meet the present-day needs of industry. Arwood Precision Casting Corporation of Brooklyn is among the concerns that have modernized this ancient art and is producing large quantities of small parts with a precision heretofore unobtainable by conventional casting methods.

The "lost-wax" process was discovered and applied thousands of years ago in China, Egypt, India, Africa, and other parts of the Old World. It was also discovered in the New World long before the appearance of white men in the Western Hemisphere. Early goldsmiths cast small objects by sculpturing wax into the desired shape. The form so fashioned was covered with wet clay in which an opening was left, was dried in the sun, and then heated, the wax melting and running out through the vent. Into this mold was poured molten metal. When it had hardened the clay was broken away, revealing the casting in the shape of the "lost" wax and with every surface detail faithfully reproduced.

Large castings were made in a similar manner but in the form of a hollow shell. A core was fashioned of clay or other material and coated with wax. After the wax had been sculptured, a layer of clay was applied. Metal pins extending from the core to the outer coating held the parts together when the mold was baked and the wax melted out. Fluid metal was then poured into the intervening space and allowed to set. When the mold was broken, the core was scraped out, the projecting ends of the pins were cut off, and the casting was finished by hand tooling. Many of the world's greatest masterpieces were thus cast in bronze by such men as Michelangelo, Leonardo da Vinci, and Benvenuto Cellini, the latter—an artisan of the sixteenth century—being particularly well known for his cast statuary.

Casting by the "lost-wax" process, also called precision casting or investment molding, is a relatively new industrial art. It was first applied around 1930 to the making of dentures and then



DIE IS FILLED WITH WAX

As a starting point, a die, made of several accurately machined pieces of metal, is assembled with screws (left). Next it is filled with molten wax which is injected from a container (right) under air pressure to force the fluid into all the recesses. Wax patterns that have been produced in this manner are shown on the table.

to the manufacture of jewelry, with no attempt at precision in either case. The advent of World War II raised numerous problems in the production of parts for new types of engines and other mechanisms because the alloys specified were often too hard to machine and too brittle to forge. When it was found that many of them could be cast to precision standards by the "lost-wax" method, the art sprang into industrial importance. It was used extensively both in this country and in Great Britain in making turbosupercharger buckets and turbine blades for jet engines and continued to expand when the war ended because it was realized that precision casting is a simple and economical process for the production of objects that are difficult to machine or forge either because of their shape or the nature of the metals used.

The growth of Arwood Precision Casting Corporation may be taken as an index of the growth of the industry. The concern started out as a 3-man department engaged in the manufacture of jewelry by the "lost-wax" method. When war needs became pressing, it set out to produce precision castings for the armed services, first making parts for aircraft instruments. The work was so satisfactory and the demand so great that the company expanded several times, eventually employing more than 100 persons and moving into its present quarters, which occupy some 30,000 square feet of floor space. Precision parts were cast for gunsights, for radar equipment, and for many other uses, and the firm was awarded the Army-Navy "E" for its contribution to the war effort. There has been no slackening of business since then, in fact the corporation is handling more work now than it did at the peak of war production.

At the Arwood plant, the initial step in precision casting is the making of the metal die with which to form the wax pattern. Some of these dies are of soft metal, but most of them are machined from stainless steel. The latter type is good for up to 300,000 impressions before losing its dimensional accuracy, as compared to some 300 for a soft-metal die. The steel die consists of several carefully machined parts that fit together to produce the finished mold, and the cavity is slightly oversize to compensate for shrinkage of both the wax and the metal used to make the casting. Calculating for oversize is one of the most difficult phases of the entire procedure and often has to be done on a trial-and-error basis.

When finished and assembled, the die is filled with hot, liquid wax by a pneumatic gun, the air pressure applied varying from 50 to 140 psi. depending upon the kind of wax employed. Pressure is maintained on the mold until the wax sets so as to make certain that all parts of it have been reached. The die is then taken apart and the wax pattern removed and inspected. Because excessive thermal expansion of the steel through contact with the hot wax might change the dimensions of successive patterns, the die is cooled with dry ice after each use. One of the requirements of successful precision casting is the accuracy of the wax pattern, and it is therefore necessary to take every precaution at this stage of the process during which dimensional variations are most likely to occur. The operation is not an automatic one, but depends to a great extent upon the experience and judgment of the worker. Sometimes it takes months to train a person for the job.

Wax patterns that pass inspection are prepared for casting by attaching the "gate" (the wax projection on the pattern formed by the opening in the die through which the molten wax enters) to a wax core called a "runner." As many patterns as possible are affixed to the core by heating the ends of the gates and holding them against the core, the resultant assembly resembling a tree, with the runner representing the trunk, the gates the branches, and the patterns the leaves. The runner and gates are the channels by which the molten metal reaches the mold cavities.

The assembly is fastened to a wax base, is placed on a flat board, and is enclosed in an open-ended cylinder of sheet metal. Both the wax base and the container are firmly secured to the board with hot wax so that accidental jostling

will not damage the delicate patterns. If the individual patterns are small, several assemblies may be grouped in one cylinder.

Christobalite is used to make the investment material. The mineral is finely ground and mixed with water to form a slurry that is poured around the wax assembly in the container. The latter is then placed on a shaking table and covered with a bell jar connected to a source of vacuum. The vibrations cause the investment material to pack itself tight around the wax assembly, while the effect of the vacuum is to draw any entrapped air out of the mixture in order to prevent the formation of air pockets or cavities. The cylinder, under a vacuum of approximately 25 inches of mercury, remains on the shaking table for from five to ten minutes. At the end of that time the investment material is allowed to set, the bottom board is knocked off, and the mold dried for an additional 24 hours before being baked.

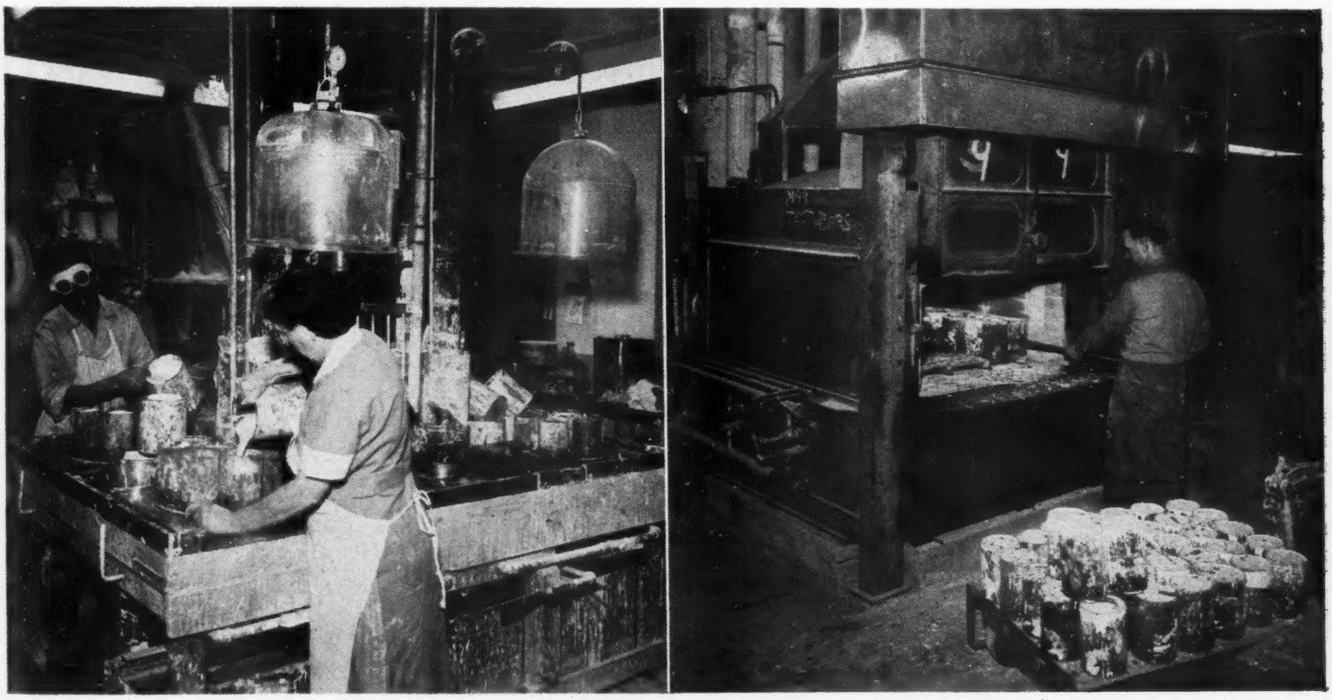
Still in their containers, the molds are stacked in a gas-fired furnace and baked for approximately four hours. At the start of this operation the temperature is low, but the heat is periodically raised a predetermined degree until, near the end of the period, it is in the neighborhood of 1200°F. The furnaces are controlled by pyrometers and are equipped with automatic shutoffs which function when the temperature becomes too high. During baking, the intense heat vaporizes the wax so that it literally disappears, leaving behind a cavity in the exact shape of the wax assembly. When adequately baked, such a mold will hold molten metal at temperatures up to 2400°. For steel, which melts at temperatures in excess of 3000°, a different type of investment material must be used.

When the molds have cooled sufficiently they are placed, four at a time, in a centrifugal casting machine. This unit is arranged for center pouring, with channels leading to each of the flasks clamped in a horizontal position in the machine. The metal or alloy to be cast is weighed out and melted in the ladle of a small, gas-fired furnace, the temperature being determined by a built-in pyrometer except in the case of steel, when an optical pyrometer is utilized. When the metal is at the proper temperature for casting, the machine is turned on and, as it revolves, the metal is poured and thrown by centrifugal force into every corner and crevice of the molds. It takes only a few seconds for the metal to harden—for the completion of the operation.

Castings that have cooled enough to be handled are removed from their containers by pushing out the core by a hydraulic ram and breaking away the investment material by means of a vibrating machine. Depending upon the type and the metal of which they are made, the castings are cleaned by sand- or shot-blasting. In either case, the particles are propelled against the work by a jet of compressed air. A similar piece of pneumatic equipment is the vapor blast which ejects a high-velocity stream of water vapor to clean out small holes and crevices that cannot be reached otherwise. These various cleaning methods remove so little metal that their effect on the dimensions of the castings may be considered as negligible.

Each casting is cut from the runner, the gate is removed, and any projecting metal is ground flush with the surrounding surface. Then it goes to the inspection room where it is visually examined for flaws or imperfections. Dimensions which must be held to close tolerances are gauged to see that they are within the permissible limits. Products intended for service where resistance to breakage is an important factor are sent out to be X-rayed for internal flaws.

The accuracy obtainable depends on the shape and size of the castings and on the alloy used. Those made of nonferrous alloys can, if necessary, be held to tolerances as low as plus or minus 0.002 inch. Ferrous alloys are more difficult to control, and such castings are generally kept within tolerances not closer than 0.004-0.005 inch. Aluminum, magnesium, and copper-base alloys make up the bulk of the nonferrous alloys, while the ferrous materials consist main-



MAKING INVESTMENT MOLDS

Several wax patterns are joined to a core or runner, also of wax, that is secured to a base and placed in a container where the investment material is poured around them, as shown at the left. The investment material is finely ground christobalite (silicon dioxide) made into a slurry. After the holders are filled, a bell jar is lowered over a group of them and vacuum is applied to withdraw trapped air. At the same time the table is vibrated to consolidate the slurry around the wax patterns. After five or ten minutes the containers are removed and set aside for 24 hours to permit the investment material to harden. The molds, still in their containers, are then placed in a gas-fired, pyrometer-controlled furnace (right) and baked for approximately four hours under gradually increasing heat. This vaporizes the wax, driving it off and leaving mold cavities that have the exact contours of the wax assemblies.

CASTING AND CLEANING

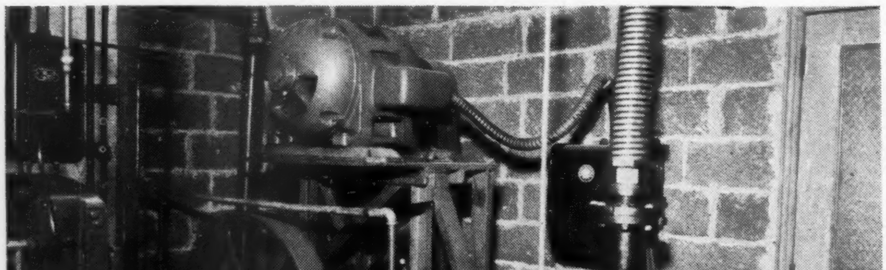
Four mold flasks are placed in a centrifugal casting machine, one in each quadrant of its circular housing. Each is connected by a channel to a central opening into which the molten metal is poured, as shown at the right. At the same time the machine is revolved at a high rate of speed to create the necessary centrifugal force that will insure complete filling of the mold cavities. The metal solidifies in a few seconds, and the castings are then removed from their flasks. After being cleaned, the individual pieces are cut from their common runner (below).

ly of stainless, alloy, and carbon steel. However, any other metal that can be cast can be handled by the process.

Because of the cost of the investment material, which is used once and then discarded, precision casting is figured on a per-piece instead of the usual per-pound basis. The size of a casting enters into the production cost to a much greater extent than does its complexity, because the cost of the investment material demands that as many patterns as possible be placed in each container. For this reason, the longest dimension of the average product of the Arwood plant is generally less than 6 inches. The number made per order varies all the way from 1 to 100,000 or more pieces.

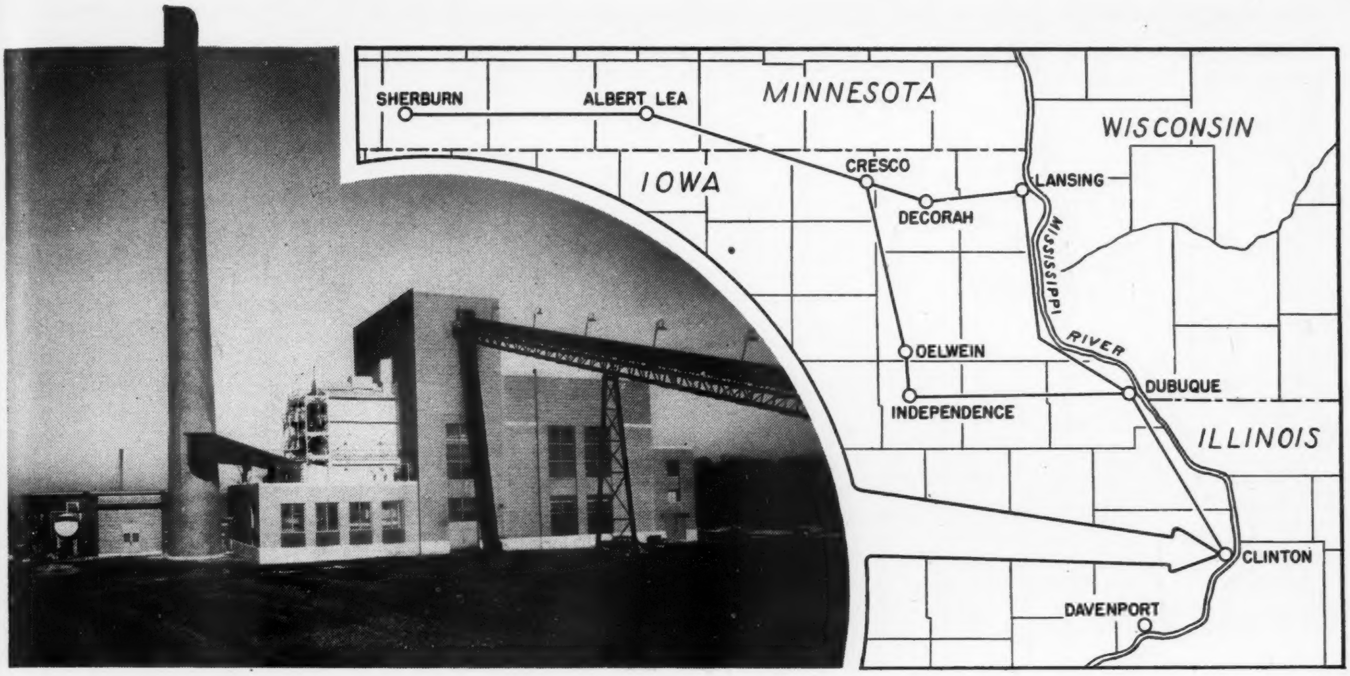
For certain kinds of work, precision casting offers many advantages over conventional machining operations. The method finds its greatest field of application in the production of small, intricate parts which must be held to close tolerances and which are difficult or impossible to grind or machine to the desired accuracy. Objects that were formerly assembled of several machined parts can often be cast in one piece. Holes can be round, square, or of any other shape, and their paths can be straight, angular, curved, or tortuous. Surfaces can be made to follow well-nigh any contour, and because the process turns out finished work, no extra grinding or machining is necessary. The amount of detail that can be picked up is amazing—markings as fine as the engine turnings on the backs of old-fashioned pocket watches are faithfully reproduced.

Arwood engineers stress the fact that the time to decide upon precision casting for a particular part is when it is first put on the drawing board. When in the planning stage, changes leading to reductions in cost and improvement in performance are easiest to make. In design, precision castings are almost the reverse of machined parts. Where the latter have to have heavy sections to gain strength, the same goal is reached in the case of precision castings by means of thin walls with ribs, fillets, and other members. If extra strength is needed, or such properties as resistance to abrasion or corrosion, an alloy is used that will insure the desired results. The fact that the lost-wax process will produce accurately dimensioned parts of intricate shape and is applicable to the softest metals and to the hardest alloys forecasts a sound future for this new and interesting method of casting.



AIR COMPRESSOR

Compressed air is used principally for injecting wax into dies and for sand- or shot-blasting castings. The machine shown is an Ingersoll-Rand single-stage unit designated as Class ER-1.



NEW STATION AND MAP OF SYSTEM

This picture of the Beaver Channel Station was taken looking across a part of its reserve supply of coal, which is moved into the plant bunkers by the inclined conveyor at the right. The white structure between the stack and the highest part of the building is the insulated, externally mounted steam generating unit. The map shows the interconnected main transmission lines of the company, which serves some 273,000 persons with electricity.

New Power Plant at Clinton, Iowa

Interstate Power Company Adds Beaver Channel Station to Its Generating Facilities

G. A. Gaffert and S. L. Chapin

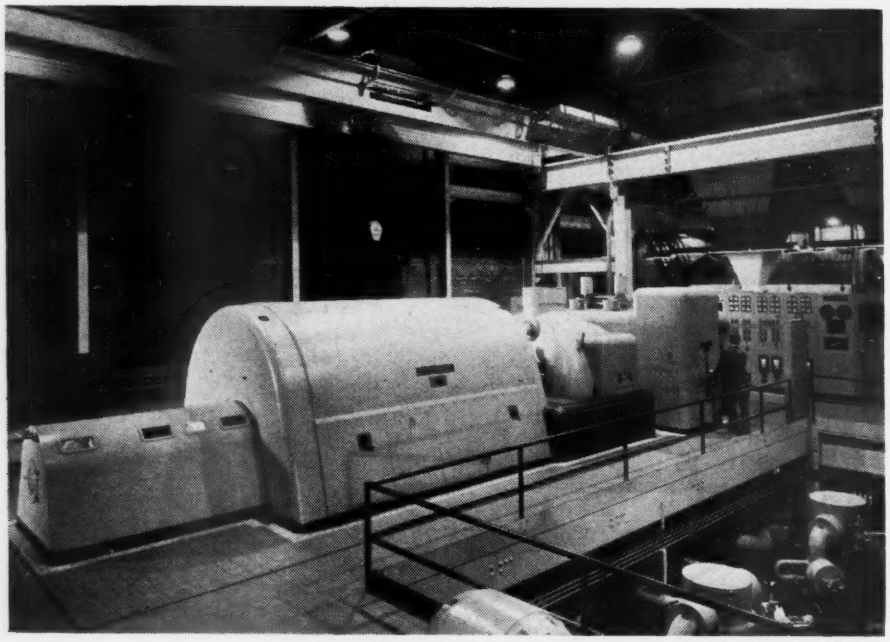
MOST manufacturing concerns recognize the importance of adequate planning for future expansion, but few carry out this phase of plant operations to the extent it is practiced by electric-power companies. Before a generating station is built, the area it is to serve is carefully surveyed and the results are given intensive study. The population growth within its radius is determined as accurately as possible, as is any increase in the number or size of the industrial establishments. If there are many farms in the area, any trend towards the use of electrical machinery is taken into consideration. Sometimes account is taken of plants using other forms of power but which, under proper economic stimuli, would be likely to convert to electric power. Altogether, these needs, trends, and indications form a basis for the expansion for which provision must be made in constructing a power station. A good example of such foresightedness is the Beaver Channel steam-powered generating plant which the Interstate Power Company has recently erected at Clinton, Iowa.

The Interstate Power Company has its headquarters at Dubuque, Iowa, and supplies eastern and northern Iowa, southern Minnesota, southwestern Wisconsin, and a section of northwestern Illinois with electric energy. Extending laterally for a distance of approximately 350 miles from eastern Iowa to southwestern Minnesota, the territory served is a farming district dotted with numerous industrial centers and has a total population of some 273,000. Scrutiny of the history of the area has shown that the electrical load on the system has approximately doubled every ten years.

The largest cities in the district are Dubuque and Clinton, both in Iowa, and Albert Lea, Minnesota. Dubuque and Albert Lea are served by plants with sufficient capacity to meet both present and future requirements, but careful study of the system as a whole, its past, and its indicated future growth, pointed to the need of more generating capacity at Clinton. That city has numerous industrial enterprises which use the corn, soybeans, and timber of the region to make a variety of finished products, and its electric load is increasing rapidly. Clinton is also an important transportation and shipping center, located as it is on the west bank of the Mississippi River, on the western route of the Chicago & Northwestern Railroad, and on the Kansas City route of the Chicago, Milwaukee, St. Paul & Pacific.

Active planning for a new power station in the Clinton area was started in the fall of 1944. Because of the large amount of cooling water that would be required, a site on the Mississippi River, or on one of its tributaries, and not too far removed from the city's industrial center was desired. After considering available properties, the plant was situated approximately 2 miles south of downtown Clinton on the bank of Beaver Channel, a branch of the Mississippi. Borings taken on the proposed site located rock extending west but dipping abruptly eastward that would furnish a sound footing for the substructure. The longitudinal axis of the new 15,000-kw. station is in a north-south direction, and it is planned to expand the plant westward and to install a maximum of four units, making an ultimate generating capacity of 60,000 kw.

Power at the Beaver Channel plant is produced by a Westinghouse 15,000-kw., direct-connected turbogenerator. It is one of the first units of its size to be



TURBINE-GENERATOR

This Westinghouse 15,000-kw., hydrogen-cooled unit is operated with steam at 600 pounds pressure and at 825°F. Steam is withdrawn from the turbine for use by nearby industrial plants, up to 50,000 pounds per hour being available for that purpose. Steam is also bled at four points for heating boiler feed water.

cooled by hydrogen. The generator is enclosed in a tightly sealed casing filled with hydrogen gas, which is a better cooling medium than air because it absorbs heat at a faster rate. Being lighter than air, it also offers less resistance to the rotor. During the operation of the generator, heat is removed from the hydrogen by cold water, which circulates continuously through tubes within the casing.

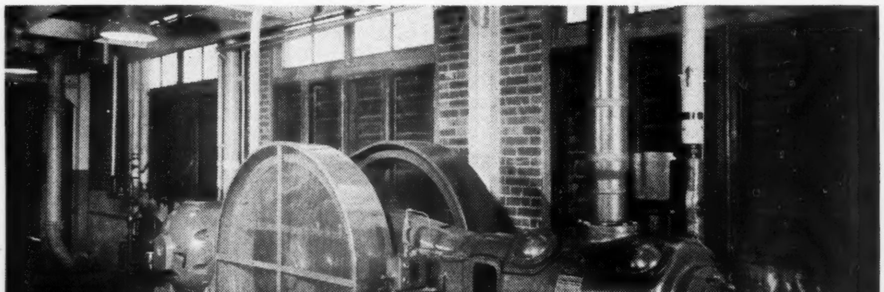
The single-cylinder condensing turbine which drives the generator is run by steam at 600 psi. pressure and 825°F. temperature. In the turbine proper, the stage following the Curtis impulse wheel is tapped for nonautomatic extraction of steam, the pressure at this stage varying with the load on the turbine. A customer located ¼ mile from the station can be supplied with steam from this source when the turbine is operating at loads as low as 8500 kw., and it is estimated that this load can be maintained under normal conditions. Altogether, up to 50,000 pounds of steam per hour is available for industrial use. In case of emergency, should the unit cease to function, a pressure-reducing and desuperheating station lowers the pressure and temperature of the steam to 175 psi. and 425°F. The turbine also has four nonautomatic bleed points which tap enough steam from its low-pressure side to preheat its own boiler feed water. By doing this with steam which has already done work in the turbine, the fuel consumption of the turbogenerator is cut down by approximately 10 percent.

Exhaust steam from the turbine is condensed in an Ingersoll-Rand unit of the surface type. The condenser contains 15,000 square feet of Admiralty-metal tubes having an outside diameter of 1 inch and an effective length of 20 feet. It is bolted directly to the turbine exhaust flange, but part of its operating weight is supported by springs which permit expansion and contraction of the condenser shell without distortion of the turbine casing.

The condenser is of the 2-pass type, and the water boxes and tubes are arranged so that the circulating water is divided into two separate circuits. This permits opening either circuit for inspection and cleaning while continuing operation of the condenser with the other water circuit.

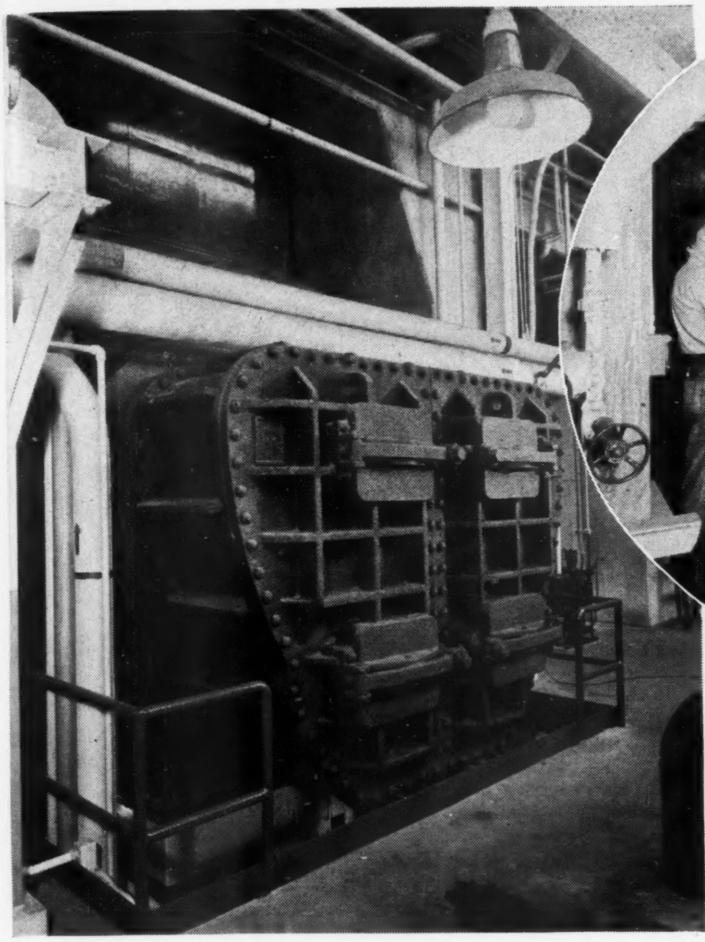
Two Ingersoll-Rand circulating-water pumps located in a crib house at the river's edge feed cooling water to the condenser through a 36-inch steel pipe line. These pumps are of the vertical, mixed-flow type and have a capacity of 10,000 gpm. against a head of 28 feet. A traveling screen at the intake of the supply pipe prevents debris from entering, and the incoming water is treated with chlorine to retard the growth of organic material that might foul the condenser tubes. After it has done its work, the cooling water is discharged into a well the overflow of which is returned to the river at a point downstream from the crib-house intake.

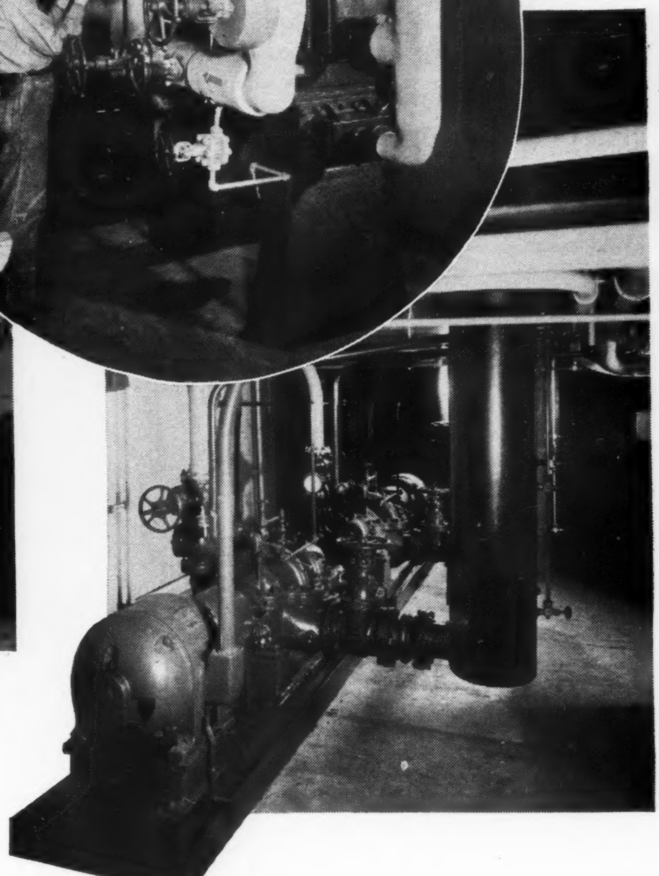
Water for the formation of steam must be free from mineral and organic matter, as well as dissolved gases, because they are the cause of rust and scale and the corrosion of boilers, condensers, and other units. River water, being too variable and containing large amounts of organic material, is not used for this purpose at the Beaver Channel Station. Instead, water of relatively constant composition is drawn from two wells, each 1778 feet deep, and passed through a water-softening and conditioning plant where it is treated with hydrogen zeolite and sodium zeolite to remove carbon-dioxide gas and other impurities. It then enters a deaerator, where it is heated to get rid of any dissolved oxygen before mixing with the turbine condensate to



AIR COMPRESSOR

This single-stage machine supplies air for operating control instruments as well as tools used in station maintenance work.





CONDENSER AND AUXILIARIES

Steam exhausted from the turbine is condensed in the 2-pass unit shown above. The condenser has 15,000 square feet of tube surface and is divided vertically in the center to permit operating one half while the other side is being cleaned or serviced. Air is evacuated from the condenser by a twin 2-stage steam jet (in circle), and condensate is removed from the hot well by either of the two Ingersoll-Rand 300-gpm. pumps pictured at the right.

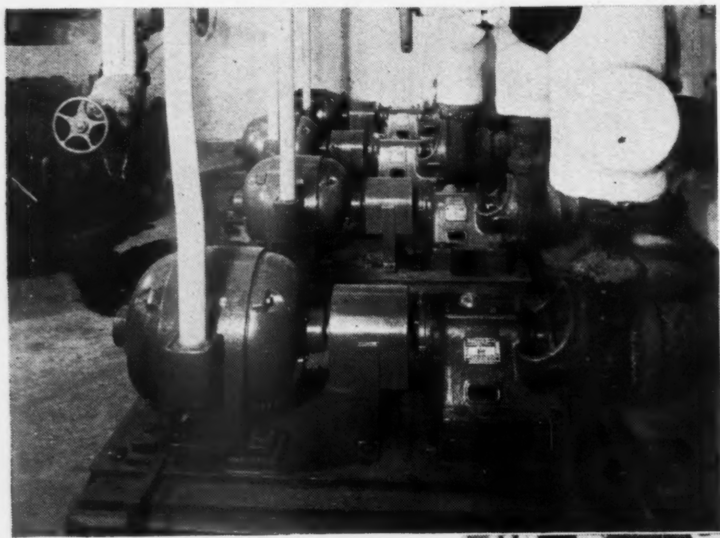
be fed through two high-pressure heaters to the steam generator. Because of the large volume of steam supplied to industrial customers and the resultant loss of condensate, the water-softening and conditioning plant is designed for continuous service to provide make-up water for the boiler feed-water cycle.

Fuel for the powerhouse comes from the central Illinois and western Indiana coal fields and is brought in either by railway or barges. Rail shipments arrive on a spur which is arranged so that the cars can be brought in, dumped, and pushed beyond the track hopper for temporary storage. Coal delivered by barge is unloaded by a revolving crane, and a motorized shifter is used to move the barges. The track hopper dumps onto a 24-inch Link conveyor-belt system having two sections: one carries the fuel up to a point where a crusher is to be installed at some future date and the other takes it from there and elevates it at the rate of 150 tons an hour to the tripper over the bunker. Coal for storage is discharged at a point midway on the latter belt and moved by a tractor fitted with a scraper blade. Ample ground is available to stockpile a 6-month's supply for the ultimate 60,000-kw. station.

The arrangement of the interior of Beaver Channel Station was planned with a view towards efficient operation by a minimum number of employees. In keeping with modern design, no division walls were built. The firing aisle of the steam-generating unit is within the building, but all other parts of the insulated and steel-encased unit are out of doors. The water column and gauge glass used with this type of boiler are inside the structure at an easily reached location. All drain and blow-off connections are similarly brought into the firing aisle as a precaution against freezing and to make them readily accessible. The floor level of the firing aisle is the same as that of the turbine gallery and extends alongside the boiler in the form of a deck which serves as a mounting for the induced-draft fan and also provides access to the steam-outlet and soot-blower heads. These features were made necessary by the inclement weather which prevails in the area for a considerable period of the year.

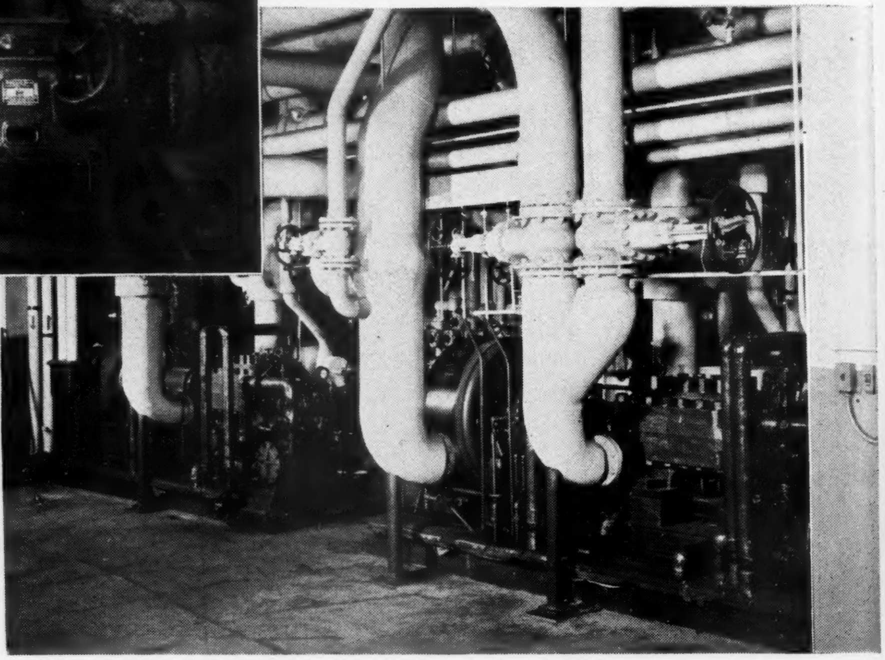
All generator, turbine, and boiler controls are centralized so that the operator can, by taking but a few steps, check both the electrical and the steam conditions in the plant. It is planned to make a right- and left-hand arrangement of the turbine boards when the generating capacity of the station is doubled. One man will therefore be able to control the two boilers and have at his command all the apparatus necessary to make adjustments. The first unit is being operated by seventeen men, and it is expected that a force of 23 will suffice for the 2-unit plant.

Power is generated at 13,200 volts and delivered to a 15,000-volt outdoor switch group consisting of main and reserve buses, together with circuit breakers of 500,000-kva. interrupting capacity. The main- and reserve-bus switch groups are



PUMPS FOR VARIOUS SERVICES

Water is delivered to the boilers at 775 pounds pressure by either of two Ingersoll-Rand 6-stage pumps (below). The one on the left, which is motor-driven, is normally in use, but in the event of power failure the turbine-driven unit at the right will insure continuous feeding. Of the four Motorpumps at the left two supply water to cool the hydrogen in which the generator runs and the other two circulate water for general service throughout the station.

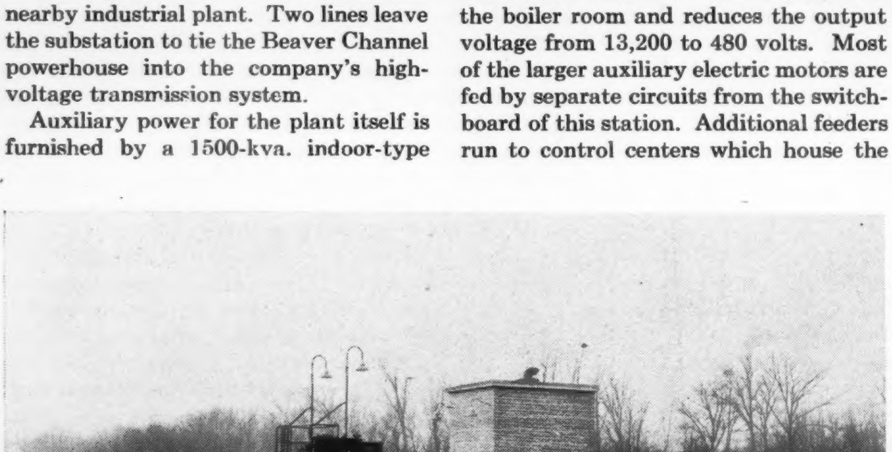


arranged in weather-tight housings in two parallel rows facing a common aisle. Two circuit breakers are provided, one in each group, for the generator and the auxiliary-power feeder. At present, breakers for each of the four feeder lines leaving the station are installed in the main group only, but the reserve group is equipped to receive them when the need for breakers arises. Of the four outgoing 13,200-volt lines, one supplies the 15,000-kva. transformer in the high-voltage substation where the current is stepped up to 69,000 volts, two extend to the city of Clinton, and one serves a nearby industrial plant. Two lines leave the substation to tie the Beaver Channel powerhouse into the company's high-voltage transmission system.

Auxiliary power for the plant itself is furnished by a 1500-kva. indoor-type substation which is in the basement of the boiler room and reduces the output voltage from 13,200 to 480 volts. Most of the larger auxiliary electric motors are fed by separate circuits from the switchboard of this station. Additional feeders run to control centers which house the starters for smaller motors mounted throughout the station at points of auxiliary load. An outdoor control center is installed at the intake crib for the circulating-water pumps and motors located at that point. The controls for the coal-handling equipment are built into an indoor control center that is placed in a separate room of the coal-crushing plant.

All motor controls in this system are electrically interlocked for protective sequence starting and stopping. Controls, instruments, and protective relays for the generator and for all feeder circuits are mounted on a control board installed on the turbine-room floor and adjacent to the boiler- and turbine-control panels, thus permitting control of the circuits by the turbine-room operator. A 250-volt station battery provides operating power for all circuit breakers and electrical devices as well as for an emergency lighting system that is automatically energized upon failure of the normal lighting source.

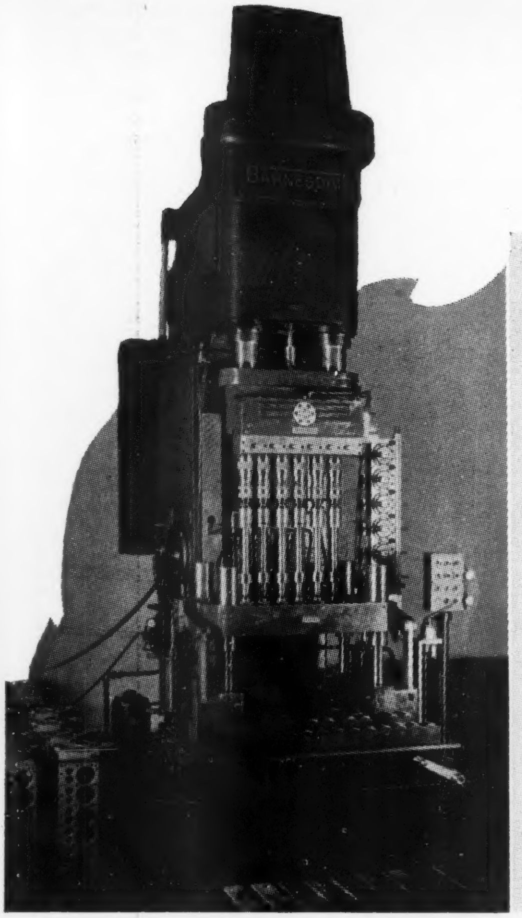
As a result of the foresight shown by company officials, Beaver Channel Station is expected to keep pace with the industrial expansion of Clinton, forming a safeguard for the basic load of that city. In addition, the plant will serve as a standby for power at Dubuque, as well as an anchor for the eastern terminus of the Interstate Power Company's electrical distribution system.

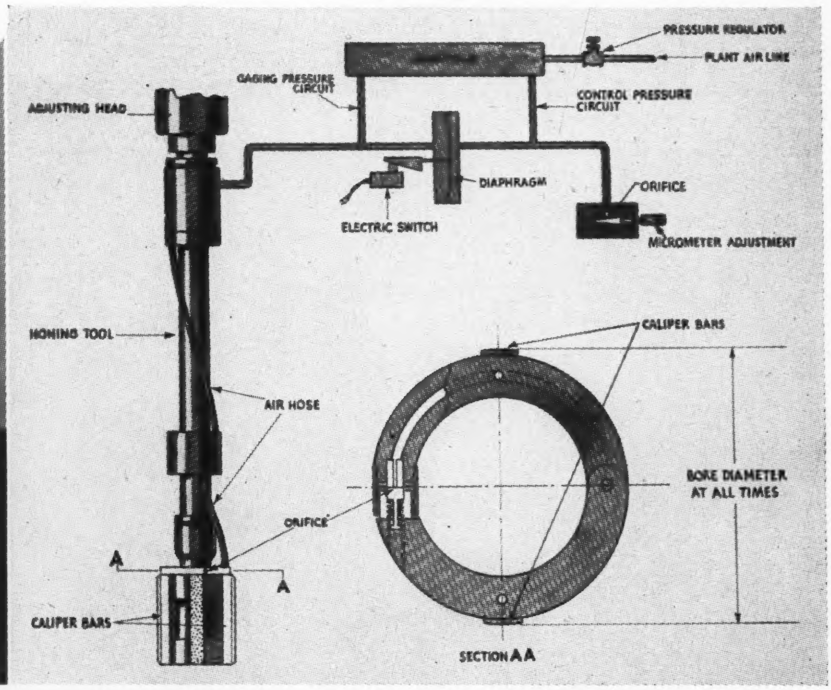


WATER-INTAKE STRUCTURE

Surmounting the concrete structure is the mechanism which operates a traveling screen that keeps out floating objects and debris. At its right are two Ingersoll-Rand vertical pumps that deliver water to the station condenser through underground piping. Each pump has a capacity of 10,000 gpm.

Air Gauge Controls Size of Cylinder Bore





SIX-SPINDLE HEAD

In operation, each automobile cylinder block is positioned in a fixture below the collapsible honing tools. The cycle is started by pressing a button, and as the tools descend into the bores they are expanded at a controlled rate by means of a hydraulic cylinder. When the pressure in an air gauge built into each tool drops to a predetermined point, sizing is finished and the tool is collapsed and withdrawn, all automatically. Note the cylinder blocks at the left of the honing machine. The drawing shows one of the tools and how the air gauge controls the operating cycle.

BECAUSE the bores of an automotive cylinder block vary in diameter, it is usually the practice in automobile plants to manufacture and stock pistons in a variety of sizes. On the production line, each bore in a block is measured and a piston selected that will give the close tolerances required for satisfactory engine performance. To lessen the need for this selective fitting, the Micromatic Hone Corporation has developed a tool that controls the finished bore size. Known as Hydrosize, it has a honing head that is expanded by a hydraulic cylinder, the rate of expansion being controlled by an air gauge. Feeding-out of the tool, collapsing and withdrawing the honing head, and compensation for abrasive wear are automatic operations.

Compressed air to actuate the gauge is taken from a plant's air line and reduced to a pressure of approximately 6 psi. before passing through Venturi fittings into two circuits—a control and a gauging circuit—which are independent of each other. Any variation in the air supply will affect both equally; but pressure in one, controlled in either by the rate at which the air is allowed to escape from it, is not affected by conditions in the other. A micrometer-adjusted metering valve regulates the pressure in the control circuit, while two caliper bars which measure the bore diameter perform the same function in the case of the gauging circuit. The pressures from both act on opposing sides of a diaphragm which operates an electric switch.

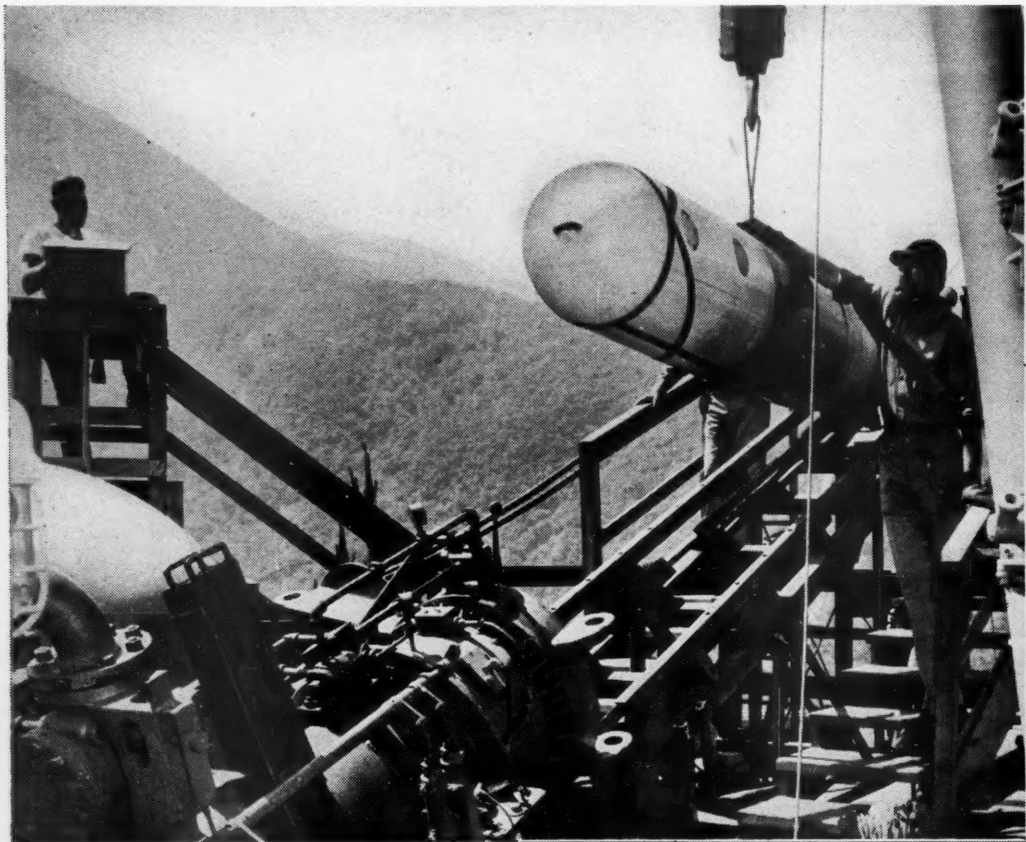
Orifices in the two circuits are adjusted so that when the bore is smaller than the size desired, the pressure in the gauging circuit is greater than that in the control circuit. When the bore has been honed to the proper size, the gauge pressure drops below that in the control circuit, causing the diaphragm to move and close the switch, thus preventing further expansion of the honing head. The tool is then automatically collapsed and withdrawn. High spots in the bore may be honed down before actual sizing begins.

Ports, undercuts, or heavy stock removal do not affect the accuracy of the tool, which may be adapted to all bores which exceed 2 inches in diameter. An example is the honing machine built by the Barnes Drill Company and equipped with a Hydrosize 6-spindle head, tools, and fixtures. In a honing cycle of 30 seconds, the equipment removes an average of 0.004 inch of stock from each of the six bores in a cylinder block, corrects out-of-roundness and taper, and holds bore-to-bore size within a limit of 0.0005 inch.

By the use of an X-ray thickness gauge developed by the General Electric Company it is possible to measure cold-rolled strip steel automatically and continuously as it comes off the finishing stands. Making no physical contact that might scratch the material, the instrument sends a beam of X-rays through the moving strip, while a second ray is transmitted through a control sample that is of the standard thickness. A radiation detector compares the intensities of the beams after they have penetrated the respective targets. If the intensities are the same, the rolled steel is of the desired thickness; if they vary, the material may be too thick or too thin. An indicator gives instantaneous warning of any deviation. Rolling tons of steel into strip that does not meet specifications is thus obviated. Carnegie Illinois Steel Company of Pittsburgh, Pa., is using one of the gauges at its Irvin Works.

COMPRESSED AIR AT WORK

Associated Activities, Inc., which processes "contest" mail for national advertisers, uses the apparatus shown at the right to recover coins that may have been discarded accidentally with box tops, wrappers, etc., sent in by entrants. The material is dumped into the hopper at the right and travels on a belt through an electronic machine that is adjusted to detect nonferrous metals only. When a coin passes through it, a switch is actuated to release a jet of compressed air that blows the particular piece of mail out at the side and deposits it in the round can. The coin-detector unit is made by Radio Corporation of America.



ACME PHOTO

To obtain information that will permit designing aerial torpedoes that will hold a true course in water after being dropped from airplanes traveling faster than those used in World War II, Navy researchers and civilian ballistic experts have fired more than 3000 missiles into the lake behind Morris Dam, Calif., since 1943. The picture above shows a torpedo being lowered by a crane into a 300-foot-long tube from which it is fired by compressed air. The inclination of the tube is fixed, but a new one now being built may be pitched as desired. The torpedoes used are of regulation size, shape, and weight, but have no explosive in their warheads.

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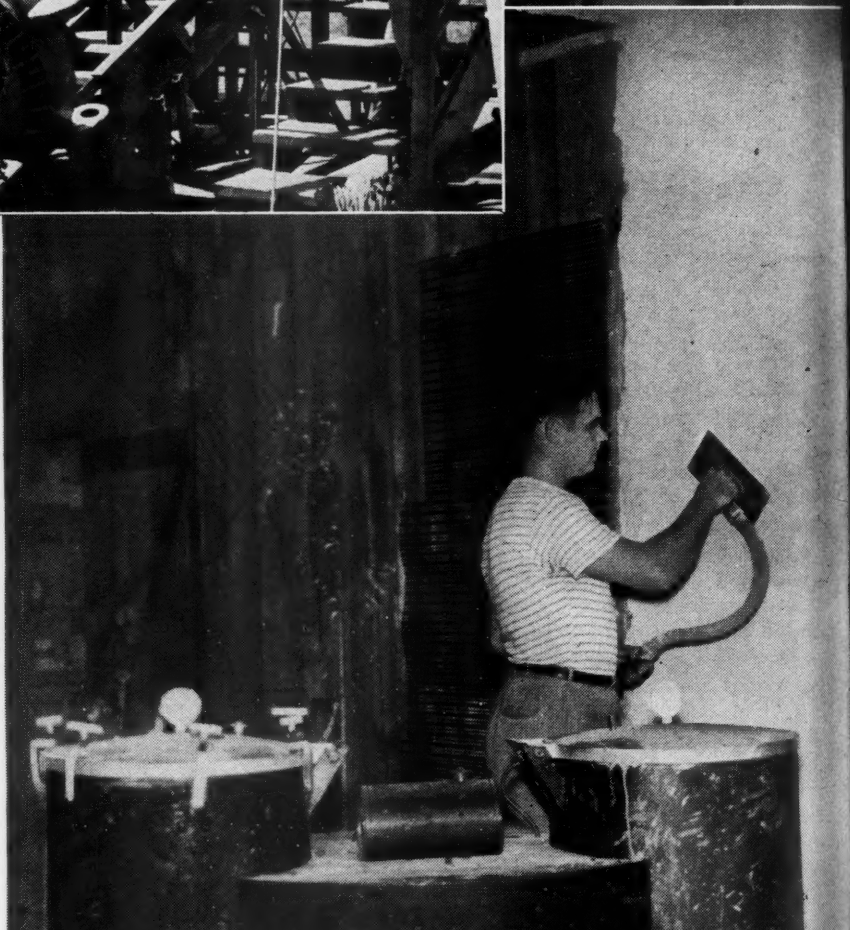


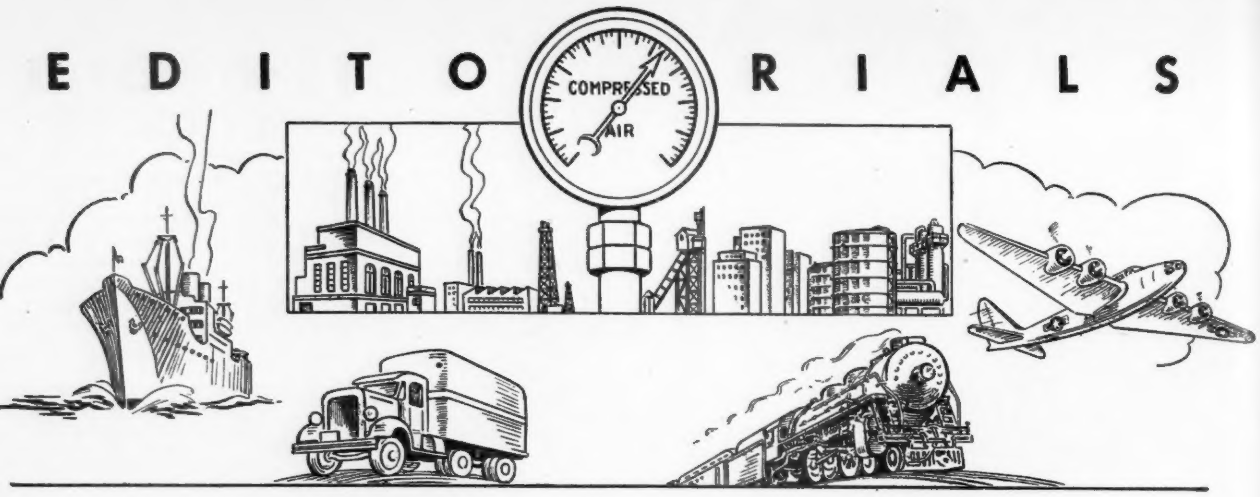
Shown at the right is James A. Hicks, Clark County, Ind., housing contractor, using the "fountain trowel" which he invented and which he claims will quadruple the speed at which wall plaster is normally applied. The outfit includes two mixing tanks with revolving paddles, an air compressor, a gasoline-engine power plant, and nonkinking hose extending to the slotted trowel. The mix is fed under air pressure, and the flow is controlled by a valve in the operator's left hand.

PHOTO FROM "CONSTRUCTION METHODS"

Facilities for making exhaustive tests of all components of gas turbines are provided in a new laboratory built by Westinghouse Electric Corporation under U.S. Navy sponsorship. The picture below shows the "hot-spin" test pit where bladed disks may be run to destruction if desired. They are whirled by a specially built compressed-air turbine that can make up to 60,000 rpm. Walls of the pit are faced with lead bricks to catch fragments for examination when the test continues to destruction. Next to the lead is laminated steel armor encased in concrete. While under test, disks are heated to actual service temperatures by radiation.

The Cochrane Foil Company, Louisville, Ky., experienced excessive breakage of aluminum foil during processing because the tension on the sheet could not be kept uniform with the mechanical brakes used on the feeding coils. Air-operated brakes supplied by Linderman Devices, Inc., have been substituted for them and permit close control of the tension by regulating the factory air-line pressure. They have virtually eliminated the difficulty. The brake shown (left), one of 25 now in service, is holding back a large coil of aluminum foil and keeps the sheet free from wrinkles as it passes into the reducing rolls.

EDITORIALS



CONTRACTING TRENDS

THE second-largest contract in dam-building history was awarded on April 21 by the U. S. Bureau of Reclamation for the construction of Hungry Horse Dam and appurtenant works on the south fork of the Flathead River, about 25 miles from the city of Kalispell, Mont. The successful bid was $43,431,000, a sum that has been exceeded only by the Hoover Dam contract in 1931 for approximately $49,000,000. (Grand Coulee Dam, larger than Hoover, was built under more than one contract.)

This serves as a reminder that construction has become very big business during the past two decades and that its growth has been accompanied by a changing pattern of management and direction. Hoover Dam ushered in an era of multifirm combinations, an idea based on the old truth that in union there is strength. Contractors merge their organizations on big jobs not only to multiply financial resources, equipment, and technical know-how but also to distribute possible losses.

Early American contractors were usually individuals or partnerships. If a really big project came along it was apportioned and let in sections. That procedure is still followed in many cases, examples being subways and aqueducts that involve huge costs. Hoover Dam wasn't susceptible of such division, and there was much speculation as to whether any contracting firm would have the resources or the courage to tackle it. Western builders solved the problem by the simple maneuver of pooling their money and brains and at the same time sharing the risks involved. The resultant Six Companies Inc. became a byword in the annals of construction and set a fashion that has proved popular.

Nine firms are coventurers in the building of Bull Shoals Dam, which is described in this issue. This is an unusually large number of participants, but scores of jobs around the country are being carried on by two or more concerns in temporary partnership. The Hungry Horse Dam group consists of three western firms: the General Construction Company of Seattle, Wash.; The Shea Company of Alhambra, Calif.; and Morrison-Knudsen Company, Inc., of Boise, Idaho. The latter two were members of the Hoover Dam sextet.

Coincident with the growth in the size of construction projects has come a comparable increase in the stature of contracting firms. At the same time, they have spread out their efforts geographically. Until fairly recent years they worked pretty much in their respective bailiwicks, but now they reach far and wide, and some of the larger ones carry on operations concurrently in many parts of the world. Exemplifying this trend are the present activities of Morrison-Knudsen listed in its employee publication *The Em Kayan*. As of May 1, it was engaged in 55 jobs on its own account and was jointly concerned with other firms in 21 additional contracts.

AIR-SUPPORTED ROOFS

SERIOUS thought is again being given to the feasibility of constructing large enclosures with membranous roofs supported solely by internal air pressure. Calculations and model tests indicate that the idea is practical, and they are backed up by one mechanically successful commercial building. However, the scheme is so revolutionary that it prompts the exercise of caution.

The conception dates back to 1917 when a British engineer suggested that envelopes of balloon cloth be inflated by blowers to serve as field hospitals during World War I. A model was made and a large exhibition enclosure was designed on the same principle, but no full-size structure was built. Technical minds were intrigued by the proposal, however, and the compiling of theoretical and experimental data continued.

In 1934, the Cargill interests of Minneapolis sponsored the construction of a 70,000-bushel grain elevator with a sheet-steel roof unsupported by internal members. After some leaks at ground level had been sealed, it was possible to keep the roof rigid by maintaining the interior air pressure at around ½ psi. The entrance was built in the form of an air lock, with double doors. The structure was in service for a year during which no mechanical difficulty developed, but it was dismantled because it was feared that the grain dust suspended in the air might explode.

Herbert S. Stevens, a New York consulting engineer, improved upon the original idea in 1942 by proposing a roof stretched as a flat metal film and then distended with air pressure into rounded form. Once it was arched in this manner the roof was to be supported by lower pressure. Mr. Stevens was granted a basic patent and has been a leading advocate of the general scheme ever since. In 1944 he headed a program of model experimentation that was conducted at New York University under the sponsorship of the War Production Board.

A year later Glenn L. Martin, the aircraft builder, became interested and was instrumental in organizing a committee of Baltimore citizens that proposed constructing a 13-acre stadium as a war memorial. It was to have a roof of aluminum sheet which, being lighter than steel, would require only a few ounces of air pressure per square inch to keep it distended. The plan was approved by the Baltimore city government but never executed.

The current revival of interest in the scheme is attributable partly to the development of a weatherproof, transparent plastic that might serve as a roofing material. In a recent article in *Nature*, Mr. Stevens points out that this opens up new fields of application for the air-support principle. A group in Salt Lake City, Utah, is exploring the idea of erecting an enclosure within which to grow food crops in arid lands. The plastic would permit sunlight to pass but prevent the moisture in the ground from escaping as vapor.

Kids Were Happy

The day before the Ringling Brothers-Barnum and Bailey circus opened in New York, it was discovered that the equipment used for inflating children's toy balloons with lighter-than-air gas was not in working order. An urgent call was made to E. F. Houghton & Company, Philadelphia, for 1300 ring packings for regulator valves in the lines leading from the tanks of compressed gas. Told of the emergency, Houghton employees put on extra speed so the order could be delivered the next day. Result: the kids had their balloons.

* * *

Lake Mead Silt

Prior to the erection of Hoover Dam, published estimates of the amount of silt carried by the Colorado River at Yuma, Ariz., placed it, in round figures, at 105,000 acre-feet, or 170,000,000 cubic yards per year. Consequently, it was known that the reservoir behind the dam would gradually fill with sediment, and this was taken into account in computing the future storage and power-generating capacity of the project. Now, after twelve years of operation, a scientific survey is being undertaken to establish just how fast silt is being deposited in this largest of man-made lakes, which is officially designated as Lake Mead.

Scientists from various governmental branches will spend ten months at that work, which will reveal just how much of the 32,000,000-acre-foot reservoir has been occupied by silt. The answer is important to the Bureau of Reclamation in determining how large a volume of water will be available in future years for generating electricity and for irrigating downstream lands. For use in the survey, the Navy has transported a miniature fleet 300 miles overland. The principal craft is a 107x21-foot barge that will serve as the mother ship. From it and other vessels, investigations of the lake-bed topography will be made by sounding, by divers, by underwater photography, by surveying methods, and by certain new techniques of "underwater television." Samples of materials deposited at various points will be collected. Final maps and reports will be prepared by the U. S. Geological Survey. The information gathered will be useful not alone in operating Hoover Dam but also in planning other dams in the Southwest on streams that carry appreciable amounts of silt.

Before Hoover Dam was built, it was expected that silt accumulation would not materially affect its operation during the 50-year period allotted for repayment of the cost. This is still believed to be true, but the survey will shed important light on the matter.

"Look out there, mister, she'll get your lunch!"

* * *

Facile Robot Hands

Mechanical "hands" that can perform such precise work as removing bottle stoppers and lighting cigarettes have been developed by John Payne, a member of the General Electric Company staff, who was inspired to create them after witnessing feats performed with artificial hands by a World War II amputee. His immediate purpose in designing them was to provide means that would permit carrying on experiments in radioactive areas without submitting the operator to radiations. In service, the hands reach over a protective 8-foot-high wall, and the manipulator observes their action with the aid of binoculars and a 4-mirror periscope. Controls are linked to the hands by arms connected to the ends of two horizontal shafts extending across the wall. The grasping action is effected by depressing foot pedals similar to an automobile brake pedal, while an electrical connection permits turning the "wrists" continuously—something humans can't do. This twisting movement enables mechanical hands to perform such work as unscrewing nuts. The device will be of service in two operations being conducted by General Electric Company for the Atomic Energy Commission.

* * *

Coulee Power Giant

On April 23, the ninth record-size hydroelectric generating unit in the west powerhouse at Grand Coulee Dam, State of Washington, went into service. This addition gives the station a rated capacity of 992,000 kw. and a peak capacity of 1,150,000 kw. or 1,541,000 hp. It is the largest concentration of power under one roof in the world. Hoover Dam's installed capacity is 1,034,800 kw. divided between two power plants.

Although the name-plate rating of the Grand Coulee units is 108,000 kw. they have been operated for prolonged periods to deliver 126,000 kw. to meet the urgent power requirements of the region served. Grand Coulee's output now exceeds the combined rating of 200 of the largest railroad locomotives and is three times that needed to light the homes of Chicago and New York combined. On the east side of the Columbia River there is room for nine more generators. The Bureau of Reclamation plans to put in three of these in 1949 and three in 1950. It is now a surety that more than three-fourths of the cost of the huge works at present under construction to irrigate 17,000 farms, comprising 216,000 acres, will be paid by the sale of power by 1952.

* * *

Drainage Tunnel Pays Off

Seven years ago the Golden Cycle Corporation completed driving the 6-mile Carlton Drainage Tunnel underneath the Cripple Creek, Colo., gold mines to permit deeper production without costly pumping. Although the mines were virtually shut down during the war and have been operated since then at far below their normal capacity, it is the opinion that the million-dollar tunnel expenditure has already been justified. In the Golden Cycle report for 1947 it states that the tunnel has functioned perfectly, with the water flow averaging 3500 gpm. It is estimated that during the 7-year operating period it has carried 16½ billion gallons, sufficient to create a lake a mile square and 82 feet deep. If that quantity of water had been pumped to the pre-

viously existing Roosevelt Tunnel, it would have cost more than the sum expended in driving the Carlton bore.

The chief beneficiary of the tunnel thus far has been the Ajax. Production from the drained zone in that mine since 1941 has yielded an aggregate net profit of $613,000. The tunnel now ends at the bottom of Portland No. 2 Shaft. The work of driving a 4000-foot lateral to the Cresson Mine and another one of 5000 feet to the Vindicator-Cycle properties has been started with a small crew of men working one shift a day. Drilling and mucking will alternate between the two headings. The report says that "there is little doubt that the ore recovered from the drained area will profitably reimburse the Golden Cycle Corporation for its costs."

★ ★ ★

Rock Drill Omelet

Some of the headaches bequeathed to mine operators in the Philippines by the Japanese during their tenancy of the islands are mentioned in a letter from Claude E. Fertig, former Colorado School of Mines student, published in *The Mines Magazine* for March. Mr. Fertig is on the staff of the Lepanto Mine, in Mountain Province, which was the islands' only prewar copper producer. Before the Americans moved out in 1942, they destroyed the surface plant. Seeking to rehabilitate the mine, the Japs transferred equipment to it from various other workings the islands over. They had visions of getting out 2000 tons of ore a day and built a small smelter to treat it, but they never exceeded a 500-ton output. However, some 6000 Japanese—mostly soldiers—and approximately 12,000 Filipino laborers and miners swarmed over the place, which became known as Little Tokyo.

"The Americans," wrote Mr. Fertig, "preceded their return by dropping 1800 tons of bombs on the camp, leaving a big pile of junk for the returning operators. Shortly after the end of the war there was a mad scramble by the other companies to get back what they could of their equipment.

"The mine is in generally good shape and my big job since my return has been to build mine equipment from what we have. At one place on the property was a huge pile of stopers of every make. The Japs had sprinkled them with fire bombs, but in the center there were many good machines. Some of the Filipino mechanics thought it a good idea to take all the machines apart and put all the various parts in one big pile, being sure that they were well mixed, and not forgetting to tear up several mucking machines, air hoists, and locomotives and mixing in their parts. Just what our rebuilt equipment will act like when we put it in service remains to be seen, but we may come forth with a new type of mining machine that breaks, slushes, and mucks, all in one operation.

"By poor mining, the Japs lost most of the ore developed by the old company. However, they did open a lot of new ore for us. Stopes were silled out to a width of 80 feet with a very rotten hanging wall. Then they decided that they had better get a little fill and went in all directions for it. I really think that the Jap super should have been glad that the end of the war cut short his job as he was certainly getting into one hell of a mess."

"If you'd make up some short starter rods I could come down off this perch."

★ ★ ★

Locates Water Supplies

Marked success in finding underground sources of water has been achieved by a New England scientist with one of the methods commonly used by oil-field geophysicists. This modern water "diviner" is the Rev. Daniel Linehan, S. J., seismologist at Weston College Observatory, a department of Boston College. His $30,000 worth of instruments are carried about in an old army truck with a top that once graced a milk wagon.

Disposing half a dozen small seismometers at strategic points, he sets off half a stick of dynamite in the bottom of a 5- or 6-foot hole. The sound waves traveling through the ground to the seismometers are amplified up to three million times. From the speed at which the waves move, Father Linehan can determine the character of the subsurface. He can thus detect the existence of sand or gravel, or other open formation that is capable of storing water. The principle is the same as that on which the equipment of petroleum geologists is based, but the technique is different.

"Shave tomorrow and wear your best clothes, we're working in the Waldorf-Astoria."

Having noted on an old geological map that the Charles River followed a different course during the preglacial era, Father Linehan located it. Now its gravel bed yields an ample supply of water for the town of Weston. The services of the priest and his staff are frequently sought by municipalities, and the Massachusetts State Department of Public Works has taken advantage of them on several occasions to learn something about the make-up of hills through which new highways are projected. When the findings indicate the presence of a solid-rock formation, the route is changed so as to avoid it.

★ ★ ★

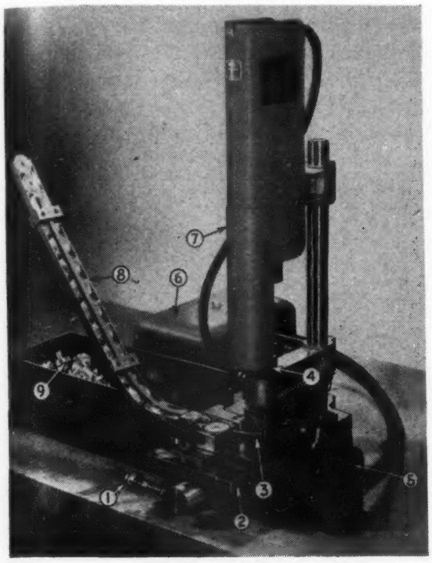
Magnetic Highway Sweepers

Many state highway departments operate trucks equipped with electromagnets to pick up metallic objects from gravel-surfaced and other types of unconsolidated roads. A survey conducted by the magazine *Better Roads* and reported on in its April issue indicates that from 1½ to 24½ pounds of ferrous material is picked up per mile, with the average around 10 pounds. In a 10-pound haul there will be from 30 to 100 potential tire puncturers such as nails, pieces of tire, chains, etc.

Most states construct their own equipment, which ordinarily consists of a 1½-ton truck with three underslung magnets powered by a gasoline engine. Either two or three trips are made to sweep the full width of a roadway, and from 10 to 40 road-miles are covered daily. Some states make it a practice to sweep oiled roads and garner from 1 to 2 pounds of metal per mile mainly from the shoulders.

Industrial Notes

Equipped with the company's new air-operated timer, Mead's pneumatic impact hammer is converted into a machine that is automatic except for opening and closing the master valve and keeping the feeder chute loaded. The



base of the hammer is of the reciprocating type and carries the work from the foot of the chute to the working position, releasing the hammer. As the slide moves back, the finished piece is ejected into a bin and the cycle is repeated. The accompanying picture shows the entire assembly. The numbered parts are: 1, two-way speed-control valve to regulate the work-holding shuttle; 2, base with feeding mechanism; 3, ejector finger; 4, tool-holding arm; 5, master valve; 6, pneumatic timer; 7, impact hammer; 8, chute; and 9, bin.

Under the name of U. S. Royal Super Service V-Belt, the United States Rubber Company is distributing a new product that is intended for power transmission for equipment such as combines and mining, oil-well, paper-processing, and other machinery that gets rough usage. The belt is reinforced with tough nylon cords covered with a special synthetic-rubber compound that withstands the deteriorating action of heat and oil. Possessing high tensile strength and elasticity, the belt is said to have four times the average life of conventional V-belting. It costs about 40 percent more than standard cotton-cord construction and is made in fractional and multiple sizes.

Two circular wire brushes mounted one on each side of an overhead conveyor chain are caused to revolve by the movement of the chain and keep it clean. The brushes are made by Osborn Manufacturing Company and are installed in the plant of a refrigerator manufacturer. They are 15 inches in diameter and effectually remove scale, dirt, and excess grease, according to reports.

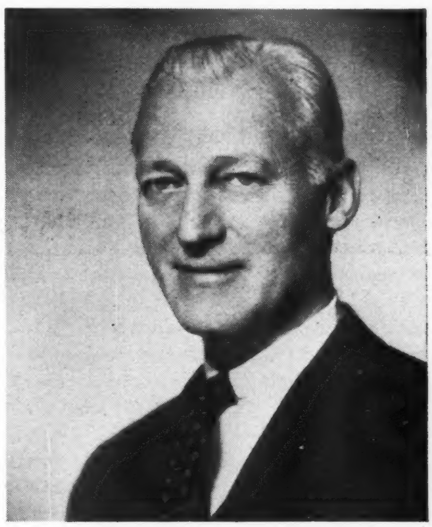
Lowebco, Inc., is offering a new synthetic paint for masonry and metal surfaces. Applied by brush or air spray, it is said to dry in from three to four hours, to form a glossy, waterproof finish that will not check or crack under expansion and contraction, and to be resistant to dilute sulphuric acid (50 percent) and nitric acid (10 percent). It is named Oncrete and is available in eight different colors for exterior and interior use.

Redi-Furred is the name of a new concrete block that differs from the usual cellular structure in that it has three air spaces extending lengthwise. One cell is long and is paralleled by two shorter ones in a single line. The design prevents moisture from passing straight through the concrete at any point, thus eliminating the need of plaster furring strips generally applied to walls built of conventional concrete blocks. It is also said to reduce heat loss by from 10 to 15 percent.

Light and power circuits on construction jobs can do double duty as communication systems by the use of telephone equipment developed by Farmers Engineering & Manufacturing Company. Consisting of a combination transmitter and receiver and of a resistor for lowering the line voltage sufficiently to operate tube heaters, speaker, and microphone, the unit makes it possible without stringing additional wires to interconnect concrete mixing plants and placing sites, materials yard and erection points, office and working areas, etc. As many surface and underground stations as may be desired can be installed, and the voice may be amplified by the aid of loudspeakers so it can be heard at remote points and over the din of construction machinery.

Pneumatic timers for varying applications are one of the products of Square D Company, which has added a type for the acceleration of mill motors. It may be actuated by separate magnets or coupled to contactors, the unit shown being of the latter kind. The time delay is dependent upon the transfer of compressed air through a metering orifice, indicated by *A* in the accompanying illustration. This permits the air to pass from the lower to the upper chamber, bringing pressure to bear against a diaphragm and thus operating the contact mechanism. The timer is reset

NEW LEADER OF "MOLES"



J. RICH STEERS, JR.

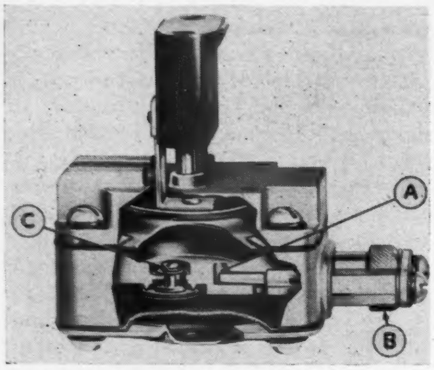
The head of the contracting firm of J. Rich Steers, Inc., has been chosen president of The Moles, New York organization of tunnel drivers and heavy-construction men. A Princeton graduate and World War I veteran, he directed construction jobs vital to the World War II effort that brought his firm the Navy E award. These included the building of two large dry docks, two piers, and a shipway at the Brooklyn Navy Yard, 1200 invasion barges, as well as an ammunition loading pier, extending 2 miles offshore, at Leonardo, N. J. The company is now constructing new ferry slips at Staten Island in New York Harbor and rebuilding war-damaged harbors in Greece.

Illustrated Lecture on Compressed Air Available

AN ILLUSTRATED lecture, *Compressed Air in Action*, has been prepared by the Committee on Education of the Compressed Air and Gas Institute for the use of industrial and technical organizations, schools, and other interested groups. Its primary purpose is to serve as a teaching aid in engineering schools, and it has been reviewed by a group of engineering professors.

Sixty-one illustrations, which are available in either 35-mm. continuous-strip film or 2x2-inch film slides, are reproduced and described in a 20-page brochure that accompanies the lecture. They show modern basic types of air-compressing machines, typical air-powered tools, as well as representative uses of air power in construction, manufacture, mining, agriculture, food processing, transportation, and maintenance.

The lecture is of 30-minute duration and can be obtained at cost from the Institute, Room 1404, Terminal Tower Building, Cleveland 13, Ohio. The 20-page brochure will be sent upon request.



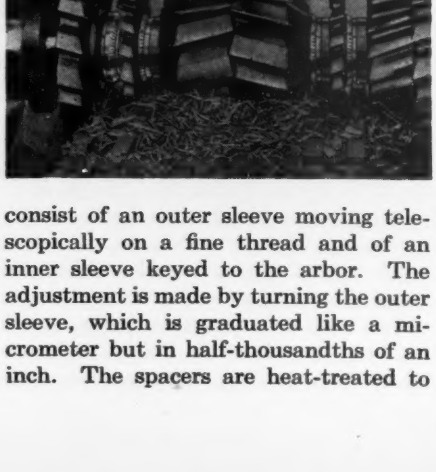
instantaneously by return of the air to the lower chamber through valve *C*. The time-delay period can be adjusted throughout a wide range by turning knurled wheel *B*. According to the manufacturer, the timer brings motors to speed quickly and smoothly regardless of load conditions and functions without danger of error through friction between moving parts, mechanical wear, or foreign material on magnet surfaces. Because of the principle upon which pneumatic timers are based, normal variations in voltage, ambient temperature, and changes in atmospheric pressure have little effect on their accuracy.

At the plant of the Heyden Chemical Corporation, returned carboys and drums are cleaned, reconditioned, and refilled with dispatch by assembly-line methods. The receiving station is at one end of a building and there the containers are inspected and defective ones are set aside for repair or replacement. The others are put on racks and successively washed with water under high pressure, rinsed, and dried with blasts of compressed air. Carboys are further examined under strong light. At the next station, outlet valves and scales are arranged so as to permit filling and weighing in one operation, and if odorous or lachrymatory chemicals are being handled, a hood is pulled down over the container opening and fumes are carried off by suction.

Rubber-covered flexible cables with broken or damaged insulating jackets can be restored to their original condition, it is claimed, by a new type of vulcanizer offered by Mine Safety Appliances Company. It consists of a mold made of aluminum to give maximum heat conductivity and of an electrical resistance unit through which automatically controlled steam pressure is applied to the mold. After the broken sections have been joined by splicing, gray insulating tape is wrapped around to a thickness slightly more than that of the old insulation. In the case of multiple cables, the conductors are grouped in proper relation to one another, the voids are filled with strips of rubber compound, and black vulcanizing tape is wound around until the area bulks a little larger than the mold cavity. Placed in the preheated mold, to which pressure is applied by three threaded studs, actual curing is said to take only a few minutes. The vulcanizer is available in three models for cables with jacketed diameters up to and including 4 inches, and with each may be used several types and sizes of molds for different repair and splicing jobs.

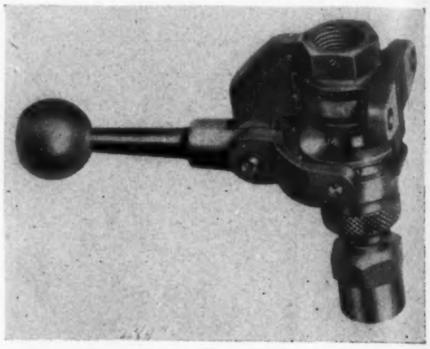
Cushman Chuck Company has announced the addition of a new series of high-speed air cylinders to its line of pneumatic power-chucking equipment. The cylinder bodies are aluminum-alloy forgings of high tensile strength and have lapped bores to insure an efficient air seal. The latter is a piston fitting with a Graphitar disk that forms a positive seal with two annular rings that are at the end of the piston rod and an integral part of it. Air ports are larger than previously, resulting in rapid piston movement and chucking of work pieces in short-run operation. After assembly, the cylinders are statically balanced to eliminate vibration and are guaranteed to function satisfactorily at speeds up to 3500 rpm. They are being produced in 4½, 6-, and 8-inch sizes.

In milling operations, when two or more cutters are mounted on an arbor, it is generally necessary to space the cutters accurately within specified limits. This is usually done on a trial-and-error basis by a combination of solid spacers, shims, and washers, often necessitating dismantling and reassembling of cutters. These difficulties are overcome, it is claimed, by the use of Euco Micrometric Expanding Milling Spacers introduced by George Scherr Company, Inc. They



consist of an outer sleeve moving telescopically on a fine thread and of an inner sleeve keyed to the arbor. The adjustment is made by turning the outer sleeve, which is graduated like a micrometer but in half-thousandths of an inch. The spacers are heat-treated to a Brinell hardness of 590 and a tensile strength of 130 tons per square inch to give years of continuous service and enable the set-up man to assemble any desired combination of cutters quickly and accurately to within 0.0005 inch.

C. B. Hunt & Son, Inc., manufacturers of Quick-as Wink air-control valves, has introduced a new hand-operated 3-way unit known as the 1291-N3. Described as compact and of strong, dependable construction, it has a stainless-steel body and adapter, a brass sleeve, and a forged bronze handle and head. The latter is equipped with a flat spring that indexes and holds the handle in "on," "off," and "hold" or "neutral" position. The valve is designed for use with single-acting air cylinders and is especially recommended for hoists when loads are to be raised, lowered, and held at an intermediate point. It is available in ⅜- and ½-inch pipe sizes and for air pressures up to 250 psi. Dimensional data sheet and complete specifications can be obtained from the company at Salem, Ohio.



Permission to proceed with the construction of what will, it is claimed, be the world's first all-aluminum bridge has been given by the authorities of Arvida, Que., which has allotted a sum of $315,000 for the purpose. The span will cross the Saguenay River and will connect Ville Racine with the works of the Aluminum Company of Canada at Arvida. It will be 500 feet long and weigh 400,000 pounds, or 755,000 pounds less than if built of steel.

Metallurgists of the Huntington Works of The International Nickel Company have developed a Monel roofing sheet that is an improvement upon the older material made there for that purpose. It has all the latter's mechanical and corrosion-resisting properties but lends itself more readily to bending, seaming, and soldering. It is suitable for well-nigh all types of roof construction, as well as for fabricating skylight framework, gutters, cornices, downspouts, etc. The sheet is available in standard roofing thicknesses and will last, it is claimed, for more than 100 years.

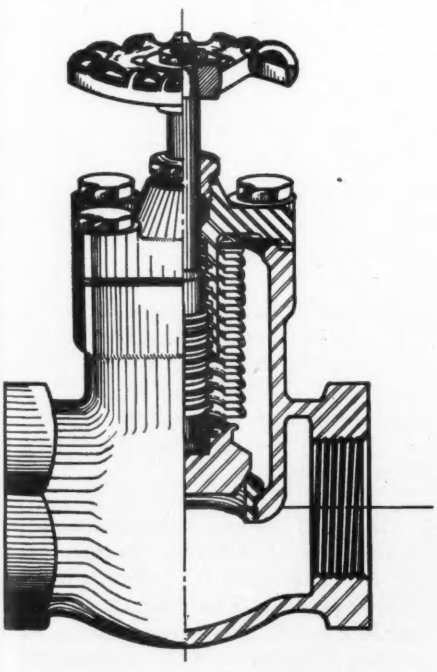
Air Plunger Helps Solve a Packaging Problem

SOAP flakes are a fragile commodity that represents unusual packaging problems. Normally they take up about 2½ times the space they occupy when packed, and they must not be mashed or broken in filling the boxes to within a given tolerance. Speed of operation is another essential that imposes difficulties in designing a machine for the work. However, there is now in use in the Armour & Company plant an automatic 8-section weighing and dispensing unit built by Triangle Package Machinery Company that is said to meet all requirements.

In service, eight cartons are delivered to the head of the weigher and moved to their respective filling stations. Not until each is spotted accurately beneath its spout does dispensing begin. Each section has two parallel vibrating feeding trays—the so-called bulk and dribble trays that handle, respectively, 80 and 20 percent of the flakes that go into a package. Amber, red, and green signal lights indicate the operating cycle. When the bulk tray has finished unloading, it is shut off and only the red light continues to burn. The dribble tray then takes over, and when the container has been brought up to the correct weight the red light goes off and a green light shines. The boxes are then conveyed to a sealing machine and another set moves under the spouts for filling.

The flakes are evenly distributed to each section by ribbon feed screws, and air-activated plungers compress them in such a way that they are not broken. Packages are handled at the rate of 75 a minute, and in case of any service interruption involving either the sealing equipment or dispenser, the latter is stopped immediately by automatic controls to prevent wastage of soap and damage to the equipment.

Fulton Sylphon Division of Robertshaw-Fulton Controls Company has announced a new leakproof, packless valve that is said to have a number of advantages over conventional types. Designated as the No. 3000 Series, it has a seamless Sylphon bellows between the valve disk and valve body, a construction that requires no maintenance and keeps the stem tight even under extremes of pressure or vacuum. Bodies are made of stainless steel, bronze, cast



iron, cast steel, or monel metal to meet varying service needs, and bellows are available in phosphor bronze, brass, stainless steel, monel, and other metals. The new valves are made in a range of sizes from ¼ inch to 3 inches with screwed, welded, or flanged ends. The screwed-end type is suitable for temperatures up to 300°F.; a yoke and external-thread construction for temperatures from 300 to 700°; and special valves are made for temperatures reaching a maximum of 1200°.

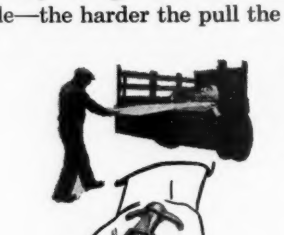
According to a recent issue of the *Iron and Coal Trades Review*, a British publication, a melting unit has been developed that combines the advantages of a coke-fired cupola and of an electric induction furnace. The upper section is of the conventional type using either hot or cold blast, but the underframe is an electric induction furnace operating at either high or low frequency. The latter may be constructed in the form of a forehearth with a spout and filled with coke or charcoal which is kept partially underneath the melting zone. In service, the iron is premelted in the cupola and delivered directly into the forehearth where it is superheated under a temperature of from 230 to 428°F. The power expended ranges from 60 to 120 kw-hrs. per ton, which is about one-fourth or one-third the energy needed when melting solid metal. As the cupola can be heated with small coke charges, the absorption of sulphur by the iron is kept within moderate limits. The fluxing action in the forehearth cleanses the coke bed of accumulating slag and permits a uniform and rapid combination of the carbon with the iron even in the presence of a high percentage of steel.

For cold and hot lines indoors and outdoors, Pittsburgh Corning Corporation is now offering a cellular material made of Foamglas in half sections 18 inches long to fit any pipe size. It is suitable for use throughout a temperature range of minus 200 to plus 800°F. and is said to retain its insulating properties per-

manently because it is not affected by humidity and is highly resistant to vapors, acid atmospheres, fire, and other elements that normally cause breakdown. Strong and rigid, the material is light in weight and easy to cut with ordinary tools. Applications include processing and other industries in which exact temperature control is required.

Previously available only in cast form, Carpenter Steel Company's acid-resisting stainless steel No. 20 is now made in wrought shapes such as hot-rolled and drawn rounds, rectangles, squares, and hexagons; centerless-ground rods; tubing; and hot and cold strip up to 8 inches wide and 0.14-inch thick. In addition to workability, it possesses all the advantages of the cast material. The alloy is said to be resistant to sulphuric, nitric, and hydrofluoric acids, as well as to all vegetable juices.

What appears to be a handy gadget for shopmen, truckers, and others who must handle sheets, plates, or other flat-surface products is being manufactured by Merrill Brothers and distributed by mill and hardware supply jobbers. It's a clamp, bearing the name of Strong Finger Grip, that is based on the well-tried 2-way wedge and level-fulcrum principle—the harder the pull the tight-



er the hold. Grip is only 6 inches long and $3\frac{1}{2}$ inches wide, weighs 28 ounces, and is provided either with a handle bar which permits it to be carried between the first and second fingers or with an eye so that it can be attached to a conveyor or lift.

Rooms in a steam-heated house can be maintained at different temperatures, we are informed, by substituting an automatic Heat Timer for the ordinary radiator valve. The new unit has a scale reading from 55 to 80°F. and functions as soon as the temperature in a room drops below the point for which the valve is set. When that happens, air is discharged from the radiator and steam enters until the temperature has been restored. Then a thermostat closes the vent. The valve is made by the Heat Timer Corporation of New York.

Industrial Literature

Methods of lubricating air compressors and pneumatic tools are discussed in a 3-color, 36-page bulletin issued by Sun Oil Company, Philadelphia 3, Pa. Cutaway views are used to explain the different methods of lubricating compressors and air tools, and specifications are given for each type of lubricant. Interested persons should request Technical Bulletin B-2.

Continental Rubber Works, Continental Building, Erie, Pa., will send to interested persons a booklet explaining the advantages that result when design engineers and rubber specialists work together to create new products. Although nontechnical, the booklet contains a chart based on SAE-ASTM specifications that provides data for engineers and others concerned with the selection of natural- or synthetic-rubber products.

Dollinger Corporation has issued a bulletin describing its line of intake air filters for all types of air compressors, diesel and gas engines, blowers, motors, and generators. Included are silencer models, regular dry-type filters, and breather filters, all featuring the radial-finned insert design. Single units range in size from 6 to 800 cfm. Copies of the bulletin may be obtained by writing to the company at Rochester 3, N. Y.

Air tools used in the fabrication of industrial products are described and illustrated in a 12-page bulletin recently issued by Ingersoll-Rand Company. Specifications and typical applications are given of air-operated screw drivers, drills, wrenches, grinders, and riveting hammers, as well as data on air hoists to handle work and on compressors to supply the tools with air. Copies of Form No. 5028 are obtainable from the company at 11 Broadway, New York 4, N. Y.

As an aid in selecting the proper cutting fluid for each machine-tool operation, Esso Standard Oil Company, 15 West Fifty-First Street, New York 19, N. Y., has published a 16-page bulletin describing the properties and applications of these fluids. Various materials used for making cutting tools are described, examples of machining practices are given, and data sheets with the machinability ratings of a number of commercial metals and alloys are included. Copies of the bulletin will be sent upon request.

B. F. Goodrich Company, Akron, Ohio, has issued a folder on the Speed-Selector, a planetary device that permits rapid, stepless changes in speed from 0 to 800 rpm. at constant torque. The mechanism is made up of two V-belts and four variable-pitch sheaves, a slight change in the sheaves resulting in a large change in output speed. The folder describes the principles of operation, pictures recent installations, and lists a large number of machines on which the Speed-Selector can be utilized. Data tables are included for the ½-, 1-, and 2-hp. models in which the machine is made.

Mechanical properties of heat-treated nickel-alloy steels are discussed in a newly revised and enlarged edition of Bulletin P-1 of International Nickel Company, Inc. Considerable additional data are given, largely in the form of charts, on the properties of the more commonly used engineering steels containing up to 5 percent nickel. Detailed information on heat-treatment methods for both carburizing and direct-hardening compositions is included, together with suggested applications of the alloys. Copies of the bulletin may be obtained from the company at 67 Wall Street, New York 5, N. Y.